THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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THE VALUE OF CONSULAR REPORTS.

IN another part of our present issue we print a brief synopsis (with comments) of a supplementary Diplomatic and Consular Report on German Trade (No. Cd. 2,236—134). A reference thereto will show the encyclopædic demands made upon the reporter. Much could be compiled by any intelligent foreign office clerk, but reviews of the operations of such diverse matters as the coal and iron industries (our eye was caught by the expression "Thomas iron," a technical expression unused in England), the engineering trade as a whole in its several branches, the chemical and textile industries, to be of any real value, need to be compiled by men for whom there is no excuse if they "miscall technicalities." Our Diplomatic and Consular Reports lack in value to the manufacturer, because their compilers, very often excellent men of business, lack a knowledge of what Mr. Swinburne would term both the "raw" and "applied science" sides of industrial operations. These reports, too, often suffer, by reason of their being prepared by men unacquainted with the technicalities of the language of a country in which they have not been born or educated. Of course, technical terms are difficult to translate, and literal renderings are apt to be curious in the extreme. The question arises as to whether, if Consular Reports are worth doing at all, they should not be so prepared as to have a definite value, to which end they should be prepared by men having a wide technical and scientific experience. A reference to the Foreign Office List for 1904 shows that the British Ambassador at Berlin has for one of his diplomatic staff a commercial attaché receiving a salary of £800 per annum. This gentleman has to act as commercial attaché, not only for Germany, but for Denmark, Holland and Sweden. The industrial requirements of the British Empire surely deserve a better intelligence department than this. It would not be one bit too much to place at Berlin several commercial attachés, say, two men specially acquainted with the textile trade (cotton and woollen), a couple of metallurgists, a mechanical engineer and an electrical engineer. Given men with keen insight, shrewd judgement, ready pens; men, above all, with 10 or more years' acquaintance with the subject upon which they write, the reports which they could provide would be of incalculable value to the United Kingdom in helping to maintain its commercial supremacy. A general who depended wholly on the reports of a number of nursemaids for information as to an enemy's movements, supplies or equipment would pay a heavy reckoning during the course of a campaign. Recent disasters to a European power in the Far East are in a large degree attributable to ignorance of the ingenuity, resources and movements of an agile, intelligent foe. With such an example at hand, we are surely justified in pleading that diplomatic and consular reports should have a real value, to which end they must be prepared by men of special training and technical knowledge.

To depend on casually selected consuls (often of foreign extraction), or on the successful candidate of an examination (the entrants to which are carefully crammed or the titled possessors of adequate political interest but no other qualification) for information in the movements and proceedings of the industrial warfare of the world, brings us perilously near to the nursemaid equivalent as a source of military information.

Gas Engine Working.

Mechanical considerations, which only seem explicable on the ground that the parts of an engine suffer more or less extension or compression under stress, all seem to point to the inadvisability of employing an abruptly explosive charge in a gas engine. The trouble with an explosive charge is that the increase of pressure due to the evolution of heat is so sudden that the parts acted upon yield suddenly to the stress, and have an equal recoil. In the Diesel engine, though the pressures are much above those of the ordinary types of combustion engines, there is no such effect observable. The engine is perfectly silent. An examination of the indicator diagram from a Diesel engine is sufficient to afford all the explanation necessary. In the first place, the piston during one stroke compresses the air imprisoned behind it to about 500 lb. pressure. This pressure is attained gradually, and the small compression or other deformation of the working parts of the engine takes place slowly; the whole period of one stroke is available. Secondly, the pressure thus attained behind the piston is not increased except occasionally; it is maintained by injecting the fuel over so long a period that the evolution of heat is only just sufficient to compensate for the increase of volume of the space behind the moving piston, the disappearance of heat in the performance of work and the loss of heat by radiation. The relief of stress in the parts of the engine then proceeds gradually as the charge expands. There is no sudden accession of pressure, therefore no sudden deformation of the parts and no noise.

It has been the practice of most gas engineers to aim at obtaining gas of rapid burning or explosive type, containing a good deal of hydrogen. A recent experience with a gas producer into which an accidental leakage of water took place, serves to illustrate the effect of this. The leakage of water produced a more powerful water gas, and the engine became noisy, beginning to crack and bang, as described by "Magneto" in our "Correspondence" columns (June 9th, p. 932.) As soon as the fault was remedied and the gas returned to its normal quality, quiet working was restored.

There is no reason why gas engines should be noisy, and they are not noisy when worked with blast furnace gas and arranged for prolonged burning, so that no sudden accession of pressure takes place. Such an engine can not only bear a higher compression, from which any further rise of pressure must start, but it can be worked so that such further rise is gradual; and though, perhaps, it is theoretically a fault in a heat engine to supply heat below the top temperature, practical considerations connected with the cold water jacket greatly diminish, if they do not entirely obviate, any loss consequent on this nominally incorrect, but really good practice.

Canal Resuscitation.

The Worcester Chamber of Commerce Committee on Canals, has promulgated a scheme for the creation of a South-West Midland Waterways Trust, which it is proposed shall buy up all the inland waterways in the Severn district, including the Kennet and Avon, the Worcester and Staffordshire, the Birmingham Canal Navigation, and a number of other navigations, aggregating in all 576½ miles.

These proprietary interests are to be vested in a trust called the Severn District Canal Trust, the value of the interests being based on 25 years' purchase of the average profits for the past 25 years, and the purchase is to be in trust stock, not in cash. The trust is to be managed by a board representing the vendors, the counties, county boroughs and Chambers of Commerce of the Severn district, the board to have full control to repair, improve, maintain, fix tolls, &c., also to work the waterways or organise boat services. A Government guarantee of dividends is proposed. This may cause opposition; but, as the *Standard* says, it were well to make a start in a homogeneous district like the Severn, and not to commit the Government to a scheme for the whole country. In all probability, the success of the first venture would stimulate private effort. It must never be forgotten that the present derelict condition of our canals is not due to natural causes; it was due to panic on the part of the shareholders, and to a deliberate policy on the part of the railways which, getting hold gradually of the nerve centres of the canal system, found themselves able in time to produce complete paralysis of every limb. We have already pointed out that in Belgium, Germany and France the canals are carefully preserved, and in Germany and Belgium are being widely extended. The steam engine builders of Ghent can sling their engines directly into ships and put them ashore in London at far less cost than probably any English engine builder: yet Ghent is an inland town.

Railway hostility will, we need hardly say, continue. This was evidenced only a few weeks ago by the opposition of three great railway companies to the Canals Bill. The promoters of this Bill did not comply with standing orders, and the Committee reported against the orders being dispensed with.

Boilers at the Liège Exhibition.

Our contemporary, *Engineering* illustrates some of the boilers at the Liège Exhibition. One of these is a Lancashire boiler, the illustration of which shows that the Belgians are by no means in the front rank with these boilers.

In the first place, the boiler is seated after the fashion of the year 1855. There are no seating blocks, but the boiler rests simply on the two side walls of the bottom flue, which are chamfered off to a breadth in contact with the boiler shell of apparently 10 or 12 in., a practice condemned long ago by the Boiler Insurance Companies. The side flues are level on the bottom with the line of contact of the bricks and boiler shell, instead of being several inches lower. The front cross wall, though it appears to be suitably recessed for the blow-out block and pipe, is apparently about a brick and a half or two bricks thick (probably two Flemish bricks). The whole boiler, in fact, is widely in contact with solid brickwork in the most disapproved style.

The furnaces are corrugated, but the remainder of the internal tubes are merely lap-jointed, and innocent of any flanged seam, while the further error of putting in no fewer than 10 water-pipes in each flue tube has been committed. An obsolete dome is attached, but the ends of the boiler are dished on the resuscitated principle of having no gusset stays.

An exhibition boiler may be supposed to be the best that can be produced, and on these grounds we should say that there is room for much improvement in Belgian boiler practice. A further error in the setting is that the course of the hot gases is down the side flues before, instead of after, passing through the bottom flue.

CAR WHEELS.

By ROBERT N. TWEEDY.

How many are the articles which have been written on this subject during the last five years? That is a problem which will remain unanswered by the combined breakfast-table forces. But how many articles worth reading have been written? How many that have transmitted the pure light of unbiassed reason and digested practical experience to the weary seeker after truth and reduced costs? That, alas, is a problem which requires for its solution no more than the primal knowledge of enumeration to which the youngest member of any breakfast table has attained.

The article on this subject appearing in the *Street Railway Journal* for March may be included, fairly enough, within the latter total, for it is evident that the figures which form its framework are derived from facts, and are not dressed up to appear before a Parliamentary Committee or Royal Commission. It should be of value to all who desire to solve the wheel problem for their own particular set of conditions, for the diagrams which illustrate the writer's conclusions, are within the comprehension of all.

Given the cost of a new wheel, and its value as scrap at any mileage, the latter involving a knowledge of the loss of weight per unit of wear; a curve can be constructed for any consignment of wheels, or for any number of consignments, so long as the buying and selling values remain the same, which will show at a glance the cost of any wheel. For instance, if a wheel is flatted to destruction so far as further use is concerned, the gravity of the offence of the driver who put on the flats can be stated exactly when the mileage has been run out. Again, if a wheel breaks, or the flanges chip, the amount which ought to be debited to the maker, if contracts were let on such advantageous terms, can be found with equal readiness.

Assuming that a steel-tired wheel can live indefinitely, a time is reached when the accumulated cost of a succession of cast-iron wheels becomes equal to the accumulated cost of a steel-tired wheel, because the successive increments, as each cast-iron wheel dies and a new one is put into work, are greater than the increments of cost due to the periodical turnings of the steel wheel, and, according to the author, this point of junction occurs at about 100,500 miles. After that point is reached, the cost of the cast-iron wheel passes the cost of the steel-tired wheel, and thereafter every mile run by the latter is nearly clear gain.

Of course, the crossing point is reached so much earlier, the shorter the average life of the cast-iron wheel or the longer the average mileage run by the tired wheel between turnings; but it follows, also, that a tired wheel is relatively very expensive if it has to be scrapped for any reason during its early life.

For instance, if it were necessary to scrap the steel wheel at 35,000 miles, the number assumed by the author as the average life of a cast-iron wheel, the comparative loss on the former would be:—(87s. prime cost and labour — 21s. scrap value) — (31s. cost of cast-iron — 11s. 6d. scrap value) = 66s. — 19s. 6d. = 46s. 6d.

Similarly at 70,000 miles, the comparative loss would be 72s. 6d. — 41s. 6d. = 31s. against the steel-tired wheel, but at 140,000 miles the balance would have turned in favour of the steel wheel, and the cost would be 85·4s. — 79s. = 6·4s., and thereafter the saving would continue to increase.

The whole point is, that the net cost of changing one wheel in a succession of cast-iron wheels is about 22s., while the cost of turning down a tire, which is assumed to be the only work requiring to be done on a steel wheel, except at its birth and death, is but 6s.

Although the figures of cost are derived from American practice, and apply to 33-in. wheels weighing 450 lb., we may take them safely as supplying a true comparison, and can use them for our own purposes in England.

So far as our experience goes, it tells us that the expectation of life of a tired-wheel at birth is not 100,000 miles, but, we must add as usual, that the expectation varies widely all over the country, whether steel or iron wheels are used, and every system must seek a law for itself.

We maintain, however, that as a general proposition, it will be cheaper to run cast-iron than tired wheels at the initial costs given above; but, anything which tends to reduce the first cost of the steel wheel, tends at the same time to modify that conclusion; and, while there is little or no room for reduction in the first cost of a *good* cast-iron wheel, there is a big opening for it in the other make.

We notice a regrettable tendency to cut down the selling price of the cast-iron wheel to meet competition; regrettable not only from the makers' point of view, but also, and chiefly, from that of the user, because the price has been cut so fine already that quality must be sacrificed if further reductions are to be made. The result of such a policy is obvious and inevitable. The trade will go, not from one maker of cast-iron wheels to another, but from the makers of cast-iron wheels to the makers of tired wheels. No one will hesitate to adopt tired wheels, when the cost per mile is demonstrably equal to that for cast-iron wheels, for they have undeniable advantages; and it is only by maintaining or improving the average life of the cast-iron wheel that it can hold its own. While the makers of steel wheels must endeavour to cut down the prime cost, which is so much greater than the cost of the cast-iron wheel, the makers of the latter cannot hope to strengthen their position materially by knocking off 5 per cent. or 10 per cent. of the selling price at the expense of mileage, for the reduction is insignificant compared to a corresponding reduction in the cost of their rival's article; rather should they make every effort to improve the quality and treatment of the material with a view to raising the average life.

On buyers we would urge again the advantage of purchasing so many wheel miles in preference to the general method of paying so much a pound. This advice applies more particularly to users of cast-iron wheels, on account of the relative value of new and old wheels. The real cost per lb. of a new wheel is not the prime cost divided by the total weight in pounds, but the prime cost divided by the weight of metal worn off at the end of its life—a very different figure.

THE CONTINENTAL ELECTRICAL ENGINEERING INDUSTRY.

The New Commercial Treaties.

The annual conference of the Association for the Protection of the Common Economic Interests of German Electrical Engineering (Verein zur Wahrung gemeinsamer Wirtschaftsinteressen der Deutschen Elektrotechnik), was held recently in Berlin under the presidency of Herr Haeffner, of Frankfort-on-Maine. Among the questions discussed the most important was that relating to the probable effects upon German trade of the new commercial treaties, upon which subject an exhaustive report was presented and a lengthy resolution eventually adopted.

The resolution, in the first place, expressed thanks for the interest manifested by the Imperial and State authorities in the conclusion of new treaties, and especially greeted the success attained in relation to Switzerland, Italy, Servia and Roumania, which treaties would presumably render it possible for the German export trade to be maintained on the whole, with the exception of cable exports to Switzerland. On the other hand, the Association strongly complained of the considerable increase in the Customs duties of Austria-Hungary, and of the directly prohibitive character of the most important duties in Russia, in which market the sale of German dynamos, motors and cables would be completely out of the question in the future, so that the German exports would experience a reduction to the extent of one-third of the total quantity; whilst the non-fixing of the duties on electrical manufactures in Belgium led to the fear of a future increase in these duties. The resolution proceeded to urge that the Imperial and State authorities should take all possible means in the agreements yet to be concluded to secure a readjustment of the position, and that in this connection there should constantly be kept in mind the fact that, in recent years competitive undertakings have been established in various countries, partly with the direct co-operation of large German companies, which undertakings mostly manufacture under considerably more favourable conditions than the members of the Association, and have either rendered competition on the part of the latter impossible or threaten soon to do so.

As far as the treaties themselves are concerned, it would seem from the terms of the resolution that the Association desires an alteration in regard to the Austrian, Russian and Belgian agreements before these are finally ratified by Germany. The reference to works founded in other countries with the aid of German firms

clearly shows that the principal Teutonic companies do not belong to the Association, as these are the identical concerns which have established manufacturing works as nominally independent enterprises in Austria and Russia, as, for instance, the Berlin Allgemeine Co., the Siemens & Halske Co., the Schuckert Co., the Lahmeyer Co. and the Helios Co.; and where amalgamations have taken place of parent works in Germany, similar fusions have proceeded both in Austria and Russia. In these circumstances it would appear that little prospect exists of any revision being proposed in the new commercial treaties, even if the contracting parties other than Germany were willing to consider the question of modification.

The Paris Société Industrielle d'Energie Electrique, which was formed a few years ago with the co-operation of several German electricity companies of the investment order, has now found that the latter are not prepared to speculate to the same extent as in former years. It is said that the German companies originally agreed to provide one-half of the capital required at any time by the branch companies formed by the Paris company in question, but it appears that they have refused more or less to subscribe for the additional capital needed by the Warsaw Electricity Co. As a consequence the Société Industrielle has been compelled to apply to French investors to a larger extent than was contemplated, an event which is reported to have aroused painful surprise in Paris.

The Vienna law proceedings surrounding the International Glow Lamp Syndicate have now reached a further stage which confirms the decision of the court of first instance. It will be remembered that the Vienna firm of Watt alleged that the Siemens & Halske Co. and the Allgemeine Co. had concluded a secret agreement as members of the glow lamp syndicate, which agreement, the firm contended, was contrary to the regulations of the syndicate. On these grounds the firm sought a declaration that the agreement should be annulled so as to cause the dissolution of the syndicate. The Vienna Oberlandes Gericht as the court of second instance has dismissed the action with costs, thus affirming the decision of the lower courts. It is a mystery why the firm of Watt, as a rival maker of glow lamps, brought the action in the Austrian law courts, when the glow lamp syndicate is a company domiciled in Berlin, unless it was thought that more success would attend legal proceedings in Vienna than in the German law courts.

German Works.

The shareholders in the Felten & Guilleaume Co., of Mulheim, have approved the accounts submitted for the past year and sanctioned an increase in the share capital from £1,800,000 to £2,750,000. As far as the accounts are concerned, these show net profits amounting to £191,688, and a dividend has been declared at the rate of 8 per cent., as compared with 5 per cent. in 1903. The increase in the share capital is intended for the absorption of the manufacturing business of the Lahmeyer Electricity Co., whose shareholders have also agreed to the transfer as from the beginning of April of this year, and also for the provision of additional working capital. In exchange for the Lahmeyer business, sites, buildings, machinery, stocks and debts owing, which are valued at £1,138,900, the Felten & Guilleaume Co. is to issue £750,000 in new shares, which, including the premium and interest, will represent a payment of £834,500 for the manufacturing property. The balance of £200,000 of the total additional capital of £950,000 is to be offered in equal halves to the shareholders in both companies. Thus the Lahmeyer Co., while retaining its financial interest in various electrical undertakings, has ceased to be a manufacturing concern, but has become a large shareholder in the Mulheim Co., whose title has been changed to that of the United Felten and Guilleaume-Lahmeyer Works Co. The reason for the amalgamation lies in the fact that in view of other fusions in recent years, the Mulheim Co. found it necessary either to erect dynamo works on its own account or associate itself with an existing firm in this branch, while the Lahmeyer Co. was confronted with a similar problem in regard to the establishment either of a cable factory or of becoming connected with one already in operation. Negotiations were opened between the two companies, with the result already outlined. The amalgamation has already been extended by the institution of intimate relations between the new company and the Land and Sea Cable Works Co., of Cologne-Nippes, the board of directors of which has been reorganised by the election to it of several members of the Felten & Guilleaume Co., which has apparently acquired a large portion of the shares in the Cologne Co. It is also stated that the latter has taken over from a Hanover firm a business for the manufacture of electrical measuring instruments.

The directors of the Hartmann & Braun Co., of Frankfort-on-Maine, in the course of their report for 1904, state that the favourable development which took place in the electrical industry in the second half of 1903 proved of advantage to the company, although the competition of numerous small works depressed prices. A lament is expressed at the lack of skilled mechanics for fine or delicate mechanism, and in order to overcome the difficulty the company has established an instruction shop in connection with its experimental workshops. A new building has been erected as an extension of the alternating current laboratory, while a second has been commenced for the reception of the department devoted to installation materials. The accounts indicate net profits of £19,157 as compared with £15,611 in 1903, and a dividend has been declared at the rate of 9 per cent. as against 8 per cent. in the previous year on a share capital of £85,000.

The report of the Norddeutsche Seekabelwerke, of Cologne, states that in the first three months of 1904 the company was fully engaged on the production of the second section—that between the Azores and New York—of the duplicate German Atlantic cable. Apart from smaller orders, the company later on commenced the manufacture for the German-Netherlands Telegraph Co. of the cables to form the lines Menado-Jap-Guam and Shanghai-Jap. The rapidity with which the cable had to be completed rendered it necessary to make various extensions at the factory, and these, together with the improvements made in the cable steamers, kept the workshops employed throughout the year. An order has been received from the Netherlands-Indian Government for a cable between Balipapan on the island of Borneo and Macassar on the Celebes islands. The company has sold the cable steamer *Von Podbielski* to the Dutch Government, which has stationed the vessel as a repairing steamer in the Dutch Indies, and a substitute of larger dimensions and power has been ordered from the Schichau shipbuilding yard at Dantzic. The accounts for 1904, after writing off £53,947 for depreciation as compared with £40,115 in the previous year, show net profits amounting to £90,156, as against £20,233 in 1903. It is proposed to pay a dividend at the rate of 8 per cent., this comparing with no distribution whatever a year ago.

The recent general meeting of the Land und Seekabelwerke, of Cologne-Nippes, approved the proposal to pay a dividend at the rate of 6 per cent. for 1904, on the share capital of £262,500, as compared with 5 per cent. in the previous year. The directors' report stated that in the later months of the year increases took place in the prices of copper, lead and rubber, but it has hitherto been impossible to advance the prices of manufactures so as to afford compensation. A complaint is made regarding the lack of attention paid to the regulations issued by the Association of German Electrical Engineers for the production of insulated wires, and in support of the statement, it is alleged that a large amount of inferior material is still being worked up. The Russian cable factory in St. Petersburg, in which the company is financially interested, was almost entirely destroyed by fire last July. The factory was fully insured, and the re-establishment of the works has been commenced. The net profits of the company amounted to £21,844, as compared with £16,405 in 1903, and the distribution to the shareholders is as already mentioned. The present year has been entered upon with a number of orders on the books.

French and Other Companies.

The accounts of the Compagnie Continentale Edison for 1904 show gross profits of £158,617 as compared with £143,523 in the previous year. After appropriating the sum of £96,800 for the purpose of depreciation as against £80,700 in 1903, the directors propose to pay a dividend at the rate of £1 12s. per share on the ordinary capital, and 8s. per share on the founder shares.

The Société Générale Belge d'Entreprises Electriques, which is a Belgian investment company interested in lighting and traction undertakings both in Belgium and other countries, has issued its report for the past year. On an ordinary share capital of £240,000 the net profits earned in 1904 amounted to £17,800, and a dividend has been declared at the rate of 6 per cent. on the ordinary shares as compared with 4 per cent. in 1903, while the holders of the 1,200 founder shares will receive 10s. per share. Among the investments included in the company's portfolio are shares in the Anglo-Argentine Tramways Co., while 2,000 shares held in another English company are entered as being of the total value of 2s. 6d.!

The report for 1904 of the Aluminium Industry Co., of Neuhausen, states that all departments were well employed, and the subsidiary branches contributed materially towards the favourable working results. As in previous years, the report again gives very little information, the reticence being apparently dictated by the desire not to make public anything likely to be of value to competitors of this exceedingly prosperous undertaking. The accounts show gross profits amounting to £129,940, as compared with £102,644 in 1903, and after writing off £49,358 for depreciation as against £32,276, the net profits allow of the payment of a dividend at the rate of 18 per cent. on a paid-up capital of £320,000. This rate compares with 16 per cent. in 1903, 15 per cent. in 1902, 13 per cent. in 1901, and 12½ per cent. in 1900. The directors state that the Héroult patents for the electrical production of steel were sold to a new company in January of the present year, and the Swiss company is largely interested in the enterprise. The prospects of the Neuhausen Co. for the current year are described as entirely satisfactory.

Among other Swiss companies may be mentioned the Basle Co. for Electrical Industry, which belongs to the Siemens & Halske group, and proposes to pay a dividend at the rate of 5 per cent. for 1904, as compared with 3 per cent. in the preceding year. The Motor Co. for Applied Electricity, of Baden, which is associated with Brown, Boveri & Co., intends to distribute 5 per cent. as against 4 per cent. in 1903; the Rheinfelden Power Transmission Co. has declared a dividend of 6¼ per cent. as contrasted with 6 per cent.; and the Franco-Swiss Electrical Industry Co. proposes to pay for the past six months a dividend at the rate of 2 per cent. per annum.

The A.E.G.-Thomson-Houston Co., of Milan, which is an amalgamation of the Italian undertakings of the Berlin Allgemeine Co. and of the Thomson-Houston de la Méditerranée, has issued its first annual report, which shows that, out of the total share capital of £240,000, the sum of £180,000 is considered as paid as to £60,000 in cash and the remainder in patents, rights, &c. In the first of the company's two departments—electric railways and lighting and power installations—it was not possible to bring to a conclusion any of the negotiations for the introduction of electrical working on the railways, and the actual work was therefore restricted to the second part of the programme. The net profits realised were insignificant, and they had been carried forward to the next account. The directors express the hope that the results for the present year will, at all events, not be behind those for 1904, especially if any of the electric railway plans are brought to a successful issue.

The turnover of the Russian Electrotechnical Works (Siemens

and Halske) Co. reached a total of £650,000 in 1904, as contrasted with £530,000 in the preceding year. After meeting working expenses, interest charges and taxes, the accounts exhibit net profits amounting to £43,227, as compared with a deficiency of £16,341 incurred in the two preceding years. It has been decided to devote the surplus for 1904 to the extinction of the deficit, and to the purpose of reserve and depreciation funds, with a balance of £4,856 to be carried forward. The directors state that it would be extraordinarily difficult to judge the prospects for the current year, although the first few months have resulted in the reception of orders of the equivalent of those booked in the corresponding period of 1904.

EDDY CURRENT LOSSES IN SOLID POLE-PIECES.*

The iron losses in dynamo machinery have always proved difficult of estimation with any accuracy, and empirical rules based more or less exclusively on experimental results have usually had to be resorted to. There are numerous reasons for the unsatisfactory checking of the experimental with the theoretical losses; the machining of the core surface and the presence of heavy iron supporting plates, &c., naturally add to the losses, to an extent which it is hardly possible to allow for by calculation. Then the method of producing the magnetic reversals in dynamo machinery, *i.e.*, by the revolution of the core instead of by alternating magnetisation as in a transformer, as well as the want of uniformity in the flux distribution, both tend to increase the losses. Finally, the losses in the pole-faces, which are not taken into direct account at all by the ordinary theory, lead to further additional losses, and the latter the writer considers the chief cause of the large discrepancy between calculation and experiment. These pole-face losses are governed by quite different laws from those which hold for the armature core, so that they must be separately calculated, and cannot be satisfactorily allowed for by simply multiplying the calculated core loss by a constant.

The high periodicity of the flux variations produced by the teeth —viz., from 500 to 2,000 periods per second in ordinary machines— suggested the attempt to calculate the losses in question by an application of Maxwell's theory of electrical vibrations. Although this theory was primarily intended to deal with the extremely high frequencies met with in connection with Leyden jar discharges and the like, there is nothing to prevent its application to lower frequencies. According to this theory, electro-magnetic waves do not pass through metals, but are more or less reflected back, owing to the fact that the waves penetrating the surface layers set up opposing currents in these, which produce an oppositely directed magnetic field. At greater depths in the metal, therefore, the original waves become extinguished, but the currents set up propagate their reversed waves, which appear as reflections of the original waves. These reflected waves are, however, somewhat weaker than the original ones, since the whole of the energy given to the induced currents is not recoverable, some being dissipated as heat. The ratio of the reflected waves to the original waves is, in fact, a measure of the eddy current losses in the metal.

If the action at the pole-face of a dynamo with slotted armature is considered, it will be seen that, by the passage of the slots and teeth, every element of the pole-piece surface, besides carrying a definite steady flux, is also subjected to a superposed periodically varying flux. This periodic flux is nothing more or less than an electro-magnetic wave, and the gradual extinction of this wave, as it penetrates within the surface, proceeds in accordance with Maxwell's theory.

In the present article, the writer shows analytically the method of applying the theory to the case in question on the assumptions:—

1. That the dielectric constant of metals is negligibly small.
2. That the flux variations follow a sine law.
3. That the length of the pole-shoe parallel to the shaft is very great compared with the slot pitch; and he arrives at the simple formulæ:

$$\left.\begin{array}{l}\text{Watts lost in eddy currents per sq. centimetre of pole-face area}\end{array}\right\} = \frac{v}{8\pi}\sqrt{\frac{v\,t_1}{8\,\mu}} \cdot (B_0)^2 \cdot 10^{-7},$$

$$\left.\begin{array}{l}\text{Depth in pole-face at which the flux fluctuations are reduced to 1 per cent. of their value at the surface of the pole}\end{array}\right\} = d = \cdot 73\sqrt{\frac{8\,t_1}{v\,\mu}} \text{ in centimetres,}$$

where v = peripheral speed of armature in cm. per second.
t_1 = slot pitch in centimetres.
8 = specific resistance (in absolute units per cm. cube) of the pole-piece material = about 10^4 for wrought-iron or steel and about 10^5 for cast-iron.
μ = the permeability (average) of the pole-piece material.
B_0 = amplitude of the flux density wave calculated by the ordinary rules for slotted armatures (see Arnold: "Die Gleichstrommaschine," Vol. I., p. 489).

At the depth, d, inside the pole-face, the flux fluctuations having only $\frac{1}{100}$ of the amplitude which they have at the surface, the energy of the waves is reduced to $(\frac{1}{100})^2$, or one ten-thousandth of its surface value.

As an example of the smallness of the penetrating power of the waves, a particular case is worked out, for which:

$t_1 = 1{\cdot}5$ cm.
$v = 1{,}500$ cm. per second.
$\mu = 1{,}000$.
$8 = 10^4$.

Here $d = \cdot 73\sqrt{\frac{10^4 \times 1{\cdot}5}{1{\cdot}5 \times 10^3 \times 10^3}} = \cdot 073$ cm., or $\cdot 73$ mm.

If an attempt is made to reduce the eddy current loss by laminating the pole-face, machining of the face should be avoided, as it is almost certain that this machining will short-circuit the laminations more or less, at least up to such a small depth as $\cdot 73$ mm., and so allow almost the same losses as in a solid pole-piece. The only useful method of lamination is that in the direction of the motion of the armature. The writer recommends that when only the pole-pieces are laminated, they should have a radial thickness of at least three-quarters of the slot pitch, as otherwise there will not be sufficient space for the flux distribution to become uniform before the solid metal is reached.

It will be seen from the first equation that the losses increase as the 1·5th power of the speed and not, as in the case of armature eddy currents, with the square of the speed. This may in some measure account for the peculiar curvature noticeable in many experimental iron loss curves. The equation also seems to make the slot pitch of only slight importance, but it must be remembered that this slot pitch comes into the expression not only directly, but also indirectly, since it (as well as the depth of working air-gap) greatly affects the value of B_0. In this way, increasing t_1 causes a marked increase in the losses calculated by the expression.

The flux density in the air-gap also has a great effect on the losses under consideration, not only because the value of B_0 is proportional to it, but also because as the flux density increases, the permeability, μ, which occurs in the denominator, falls off rapidly. With cast-iron pole-pieces, especially, the permeability may fall to very low values, and so, in spite of the increased resistance, 8, of cast-iron, may lead to heavy losses.

Losses of the amounts estimated by this method would go a long way towards accounting for the differences between the calculated and actual iron losses met with in practice.

In conclusion, the writer investigates the probable limits of accuracy of his equations, and shows that the only probable source of error is the difficulty of accurately determining the values of the resistance, 8, and the average permeability, μ, especially at machined surfaces, where the treatment received by the iron may cause both these quantities to reach different values from those obtained, by experiments on the material in bulk.

* Abstract of an article by R. Rüdenberg, in *E.T.Z.* for February 23rd, 1905.

GERMAN ELECTRICAL ACTIVITY.

A supplementary report has just been issued by the Foreign Office on German trade during 1904. It is chiefly interesting to electrical engineers on account of its review of the German electrical industries from the internal point of view rather than from the external aspect of mere imports and exports. A deserved tribute is paid to the admirable organisation of the leading firms. Coalescing around the Siemens & Halske and A.E.G. undertakings, two strong groups monopolise the greater part of the business. Evidences are not lacking of a fusion of these interests, as these two firms have "pooled" their wireless telegraph patents, and also work conjointly at Valparaiso and Warsaw. Despite protection, the favourite panacea of Mr. G. Byng for all industrial ills, prices have not been satisfactory, and "several makers of special articles complained of loss of business through the competition of the great combines." Combines seem to be the order of the day, and the usefulness of the international glow lamp cartel is ascribed to the fact no works are established within the protected area which do not belong to the cartel. It is stated that the carbon filament lamp encounters considerable competition from the Nernst and osmium lamps. Accumulator manufacturing has also fallen into the hands of a cartel headed by the Akkumulatorenfabrik Aktien-Gesellschaft.

Cable works and manufacturers of conductors, apparatus and accessories, were affected by the prevailing high prices of copper and dielectric substances generally. One paragraph requires further elucidation. It is stated that "trade in the weak current industry . . . . was satisfactory, but here also the rise in the prices of raw materials was not accompanied by an adequate advance of the prices of manufactured goods." Readers who are not familiar with the peculiar German practice of dividing the electrical industry into two great branches—the "weak" and "strong" current sections respectively—may well be puzzled when they come across such an expression as the one which Mr. Consul-General Schwabach has translated in this manner.

Large power distribution companies are now the order of the day, and bulk supply is largely undertaken. The Brühl Works of the Berggeist Co. supply 66 places within a radius of 10 to 15 miles; the Upper Silesian Electric Works supply the whole surrounding industrial district, while the Rheinfelden and Neckar Works supply respectively 46 and 40 localities. Home industries are being developed by the use of the electric motor, notably at the Anrath

Works, near Crefeld, which turn out and supply ¼ to ½-H.P. motors for driving silk ribbon looms.

The general increase of electricity as a motive power is stated to be progressing at a greater rate than the increase for lighting purposes. The Berlin generating stations supplied, according to the official with the aggressively British surname, in 1897, 7,224 KW. for power purposes, exclusive of electric traction, and 14,601 KW. for lighting; in 1904 for motive power, 44,448 KW.; for lighting, 36,196. What is precisely meant is decidedly obscure—perhaps thousand kilowatt-hours is meant by kilowatts. The figures as given may mean a great deal to the Foreign Office pundits who edit these reports. To readers of the ELECTRICAL REVIEW their meaning might provide material for a guessing competition. The writer of the report is on surer ground when he states that the number of motors supplied increased from 2,056 to 12,933. This figure, while interesting academically, obviously lacks the essential elements of aggregate horse-power; the inclusion of a note on the prices per kilowatt-hour for the energy supplied would have done somewhat to rehabilitate the reputation of the author of these notes.

An estimate is quoted in the report as to the number of hands employed in the German electrical industry being 72,500 in 1904, compared with 26,300 in 1895 and 54,000 in 1898. Of the estimated number for 1904, the A.E.G. and allied firms employed in all 29,000 hands, the Siemens-Schuckert combination employed 12,000 hands, and the remaining 43,000 (*sic*) are distributed among the electric speciality manufactories, numbering about 225. The total capital invested in the electrical industry (presumably manufacturing only) is estimated at £30,000,000.

A MODEL METER DEPARTMENT.

ON the proper organisation of the meter-testing department of a supply system, immunity from complaint and the successful building-up of business largely depends. The ordinary consumer, being unable to grasp anything more tangible than that he must pay the bill according to the reading of a meter, is apt to be very indignant if that meter can be proved to be wrong. The New York Edison Co. have recognised this in thoroughly equipping a proper meter department, and making the complete inspection of meters a matter of routine. From our American contemporary, the *Electrical World and Engineer*, we have abstracted the following *résumé* of the operations carried out by this department.

Testing is carried out both by the ammeter and voltmeter method, and by the rotating standard method. The ammeter used for all meters of usual size is a standard ironclad Weston millivoltmeter and shunt, having scales of 1·5, 15 and 150 amperes. The Weston ironclad voltmeter used has scales of 150 and 300 volts. The rotating multiple field-coil standards used in the larger part of the outside tests are carefully checked each day before commencing work, and are found to remain accurate for a long time, being fitted with cupped diamond jewel bearings. These standards are also checked when necessary against primary standard voltmeters and potentiometers and standard ammeters kept in a special test laboratory provided with a 150-cell storage battery for potentials to 300, and a 10-cell storage battery giving 1,250 amperes at the hour discharge rate. Frequent comparisons with independent laboratories situated in the vicinity of New York prevent the slightest deviation from the United States standards. The personal element in outside testing is eliminated by testing individual supply meters at periodic intervals in the test laboratory, these giving a check on the results of each outside meter tester. In addition to this standardising laboratory, the company has three testing offices in different districts, to each of which the rotary standards used on installation tests are daily brought for checking. One of these offices—the main depôt of the department—has in addition an elaborate direct current test board for the calibration of all meters as received from the manufacturer, an alternating current testing board, a well-equipped repair shop, and a meter store having a stock of some 5,000 meters always ready for installation. There is here a clock having an electrical attachment to a relay and sounder, which gives beats of standard seconds, and every stop-watch used in testing is checked by it at least once a day. The direct-current board, large enough for eight men to test simultaneously, provides for series, separate or parallel testing, current is supplied at 120 or 240 volts by three-wire connections of 1,500-ampere capacity from the main station bus-bars, while E.M.F.'s up to 250 volts are obtained from a storage battery of 7½-ampere capacity at the 8-hour discharge rate. The meters under test are suspended from air-cushions placed upon racks, to avoid vibration due to station machinery. Any required current is obtained by using a bank of 1,100 lamps suitably grouped. Spare parts, such as armatures, shunts, resistances, fields and frames are kept in stock, and the repair shop includes apparatus for renewing and testing the component parts of meters, such as armatures, magnets and jewels. Repaired or rewound armatures are tested for resistance and insulation; strengths of magnets are tested against a standard magnet by the torque due to eddy-currents developed in two copper disks on a common spindle, one rotating between the poles of the standard, the other between those of the magnet to be tested. The counterweight needed to bring back the latter to a fixed position when the standard has a certain deflection affords a comparison of strength. As a result of accuracy tests extending over four years, all meters of above 15-ampere capacity have been equipped with diamond bearings, and the application of this improvement is to be extended.

The type, capacity, and maker's number of each commercial meter is recorded as soon as it is received from the manufacturer, and a company's reference number is assigned to it. The meter is then tested for correct calibration before being sent to the store room. After the contract and inspection department has advised the distribution department that a certain installation has been approved by the Board of Fire Underwriters, a meter of proper capacity is withdrawn from store, and the meter department advised that the instrument has been officially connected. Within a week of its installation a regular inspection of the meter is made. This is followed in five or six weeks by a so-called "first test," this being necessary from the fact that the commutators of direct-current meters become thinly coated with oxide after a short period of service, the meter tending to run slowly. In addition to this triple safeguard to the consumer, each meter is tested at least annually, those of larger size every three to six months, depending on their use. Upon complaint by a consumer of excessive charge additional tests are made at the company's expense, and no objection is raised by the company to the attendance at the test of an expert on behalf of the consumer. The results of all tests are reported on form test-cards, checked by the district foreman, and recorded in the departments' books for reference. In addition to the direct-current service, New York has an alternating-current 60-period supply, while high-tension three-phase transmission is effected to outlying districts at 25 periods. The meter department has to, therefore, test all sizes and types of alternating-current meters in addition to its direct-current work.

The work accomplished by the department may be gauged by the fact that the total number of tests of supply meters was over 82,000 during the year 1904, at least two inspections per instrument being made.

PARLIAMENTARY.

The Telephone Committee.

Wednesday, June 7th.

MR. W. E. L. GAINE, the general manager of the National Telephone Co., Ltd., was called. He said that the National Telephone Co.'s operations extended throughout Great Britain and Ireland. Prior to the trunk wires being taken over by the Post Office in 1896, the company's license from the Postmaster-General extended generally throughout Great Britain and Ireland, but upon the acquisition of the trunk wires by the Post Office the country was mapped out into telephone areas, the work of transmitting messages between areas being undertaken by the Post Office. The company was now operating in 280 areas, in which it had, on March 31st last, 1,139 exchanges, and 326,017 telephone stations, which latter figure included 5,365 public call offices. According to the last return (November, 1904) the company was transmitting telephonic messages at the rate of 995,671,664 per annum. The company had approximately 683,000 miles of wires, of which 439,300, or 64·4 per cent., were underground, and the company rented upwards of 42,000 miles of underground wire from the Post Office. During the past 10 years the company had been actively engaged in replacing the old single-wire lines by the most up-to-date metallic circuit plant, and underground, in nearly all the principal towns in the country by arrangement with the local authority. Out of the total of the company's exchange equipment at the present time only 0·2 per cent. was earth circuit. Witness then proceeded to speak of the amalgamation of the various telephone companies in 1889, and put in the following table to show the growth of his company:—

STATEMENT OF CAPITAL AND REVENUE OF NATIONAL TELEPHONE CO., LTD.

Period.	Amount of capital account as at each date.	Gross revenue.	Net revenue after payment of all working expenses and Post Office Royalty.	Total amount of reserve fund as at end of each period.
	£	£	£	£
Year to April 30th, 1890 ..	2,589,120	880,075	191,991	53,500
" " 1891 ..	3,050,453	431,112	195,047	98,500
" " 1892 ..	3,371,445	463,741	187,250	104,627
" " 1893 ..	4,040,985	588,590	217,725	134,627
14 months to June 30th, 1894	4,463,328	800,545	316,454	225,000
Half-year to Dec. 31st, 1894	4,603,569	378,789	138,648	260,000
Year to December 31st, 1895	4,941,569	819,034	335,195	350,630
" " 1896	5,078,772	870,746	331,506	489,256
" " 1897	5,600,925	984,557	375,486	510,671
" " 1898	6,549,056	1,112,666	424,573	628,789
" " 1899	7,187,547	1,266,168	498,746	768,702
" " 1900	8,096,514	1,432,696	528,159	883,891
" " 1901	8,674,576	1,576,210	574,701	1,001,257
" " 1902	9,250,113	1,691,706	635,389	1,212,882
" " 1903	9,990,140	1,835,843	690,435	1,452,140
" " 1904	10,840,780	2,018,980	759,422	1,618,410

Continuing, WITNESS said that Mr. Babington Smith, in the course of his evidence, was questioned with regard to the evidence of Mr. Lamb, assistant secretary to the Post Office in 1892, before the Select Committee on the Telegraph Bill of that year. Mr. Lamb, in answer to a question, had said: "My impression is that 19 years hence their (the company's) existing plant would not be worth more than about a million pounds." Witness considered that Mr. Lamb had no adequate information to enable him to form such an impression. At the time he was speaking, the capital expenditure of the company amounted to only £3,371,445, as against £10,840,780 on

December 31st last. Mr. Lamb was speaking of the value in 1911 of the plant which was in existence in 1892, and the best answer to Mr. Lamb's impression was that for all practical purposes, the whole of the plant to which he referred had now been swept away and replaced. If there had been any left, it would have disappeared long before 1911. Since Mr. Lamb's evidence the company had spent £2,941,842 on maintenance, renewal, and replacement of plant, entirely out of revenue. It might interest the Committee to hear that the average age of the existing plant in use was only about four years. Referring to the remarks which the late Mr. Hanbury had on more than one occasion made with regard to the company's plant, Mr. Gaine said that the company considered that they were quite unfair. The company had been the pioneer in the adoption of modern improvements such as the common battery system of switchboards. This system they adopted before the Post Office did so. The company had also sent him (the witness) with their chief technical officer, three times to America within the past six years, and he had adopted and brought into use in this country all the most approved methods for dealing with telephone traffic, which experience in the States and Canada had justified. In his opinion, the greatest development of the telephone business had taken place in America, and notably in New York. During the past five years the company's business had increased in stations at the rate of 12·4 per cent. per annum, but in New York the increase had been 29·7 per cent. per annum, notwithstanding the higher charges in New York. Witness then read the following extract from a report which he made on his return home from his visit to America in January of last year:—

"The capital invested in the telephone enterprise in America, and controlled by the American Telephone and Telegraph Co. is about £48,000,000, and during the past three years the new capital brought into the business has averaged each year upwards of £8,000,000. During the present year it will exceed £10,000,000.

"I am satisfied that if this company was in a position to canvass freely and to develop the business properly, the number of telephone users in this country could be more than doubled in a comparatively short time. I am of opinion that provision will have to be made for the expenditure on the telephone system of this county of upwards of £10,000,000 of new capital within the next few years.

"In examining into the telephone systems both in America and Canada, we naturally devoted time and attention to the question of plant. Acting upon the advice of its technical officers, this company has, during the last few years, arrived at the conclusion that the common battery or central energy system of working is that which is ultimately going to survive. Very large sums have already been spent in equipment of this character both in London and the provinces, and the company has heavy commitments in this direction before it, especially in London. The Post Office has adopted this plan for its London system. With few exceptions all the great towns both in America and Canada are working common battery switchboards. The conclusion at which I arrived after my previous visit to the States is fully confirmed, and I am quite clear that all the money which the company has spent, and is pledged to spend in this connection, is, and will be, money well spent."

Continuing, Mr. Gaine said that it had been suggested that the company had been nursed by the Post Office, but that was not his experience, for the company had never obtained anything from the Post Office without having to pay for it. The history of the telephone in Great Britain had been how not to do it; for there had been no continuity of policy, and every impediment had been put in the company's way. In the case of London, nobody was more responsible for retarding the development of the service than the London County Council. In the view of the board of his company, the bargain which the Post Office sought was a hard one, because it gave no consideration in respect of the goodwill of the great business, with its present gross revenue of over £2,000,000, and net revenue of over £750,000 per annum, which the company had built up. The company had had to pay for all experiments and mistakes, and it had already paid the Post Office in royalties £1,848,059. The Post Office was to step into the business in 1911 by paying only for the plant employed. In the view of the company it was unfair that the Postmaster-General should have the right to pick and choose what plant he would take. The company's proposals might be summarised as follows:—(*a*) That the change on the ownership of the undertaking should not detrimentally affect the staff; (*b*) that so far as may be practicable there should be continuity of service; (*c*) that there should be compensation for loss of office based upon the precedent of the Metropolitan Water Act, 1902; (*d*) That the company's pension fund should be kept alive, and its contributing members dealt with in accordance with the provisions of the pension fund trust deed. These were the proposals which the board had suggested, but the Post Office would not agree to them, and the board struggled against the decision up to the last moment.

(To be continued.)

Pudsey Corporation Tramways.—Messrs. Dyson & Co., Parliamentary agents, have deposited a petition with the House of Lords praying for leave for the Yorkshire Electric Power Co., to be heard by counsel against the Pudsey Corporation Tramways Order in Tramways Orders Confirmation (No. 1) Bill, although the time limited by the Standing Orders for making such application has expired.

Third Reading.—In the House of Commons on June 7th the Shropshire, Worcestershire and Staffordshire Electric Power Bill and the Metropolitan Railway Bill were ordered for third reading.

Second Reading.—In the House of Commons on June 7th the following Bills were read a second time:—Gosport and Fareham Tramways Bill, Hastings Tramways Bill, Metropolitan and Great Central Railway Companies' Bill and South Lancashire Tramways Bill.

LEGAL.

Acetylene Gas and Electric Smelting Co.

Lords Justices Vaughan-Williams, Romer and Stirling again had before them on Thursday last week the appeal of Mr. J. W. Heywood from the decision of Mr. Justice Buckley refusing an order for the winding up of the company on the ground that the petitioner's debt was too small. The case had been adjourned to enable the petitioner to communicate with the company's works at Strangford, in Norway, and make inquiries as to their position generally. As a result of their inquiries, they had found that the company had no works at Strangford. The owner of the only works at Strangford wrote that Messrs. Baggallay & Co., of Leeds, had offered to buy the works, but having no cash and no references, the offer was refused. The company were tenants of a certain mill at Ingleton, in Yorkshire, but it had been burnt down, and a Mr. Middleditch, who was a shareholder in the company, was in possession as mortgagee. Counsel said he had affidavits showing that the company were still carrying on business at 5 and 7, Basinghall Street, Leeds, and the petitioner believed there were assets somewhere.

Their Lordships intimated that they could not grant the order on the information before them, but allowed it to stand over *sine die* in case further information was obtained as to the assets of the company.

A Question of Tram Tickets.

At the Nottingham Guildhall on 6th inst. William W. Simpson, secretary of the Derby and Nottingham Electric Power Co., was charged by the Tramways Committee of the Nottingham Corporation with refusing to produce his ticket when it was demanded by an authorised person, and also with refusing to pay his fare for the distance travelled over when the same was lawfully demanded.

Mr. H. W. Stevenson (instructed by Mr. H. P. Day, of the Town Clerk's Department), in opening the case, said that Mr. Simpson seemed to have got an impression that he was not bound by the bye-laws, and he had probably seen reports of the case contested in Sheffield by Mr. Muir Wilson, and was of opinion that he need not accept or produce a ticket when demanded. He (Mr. Stevenson) would point out that, in Mr. Wilson's case, the acceptance of the ticket by a passenger reduced the Corporation's liability in case of accident to £25, whereas in Nottingham no such condition was attached. The maximum penalty under the bye-laws was £2, and he asked that such a fine as the magistrates thought reasonable should be inflicted. If such cases were constantly taking place, the business of the tramways would be absolutely disorganised.

Mr. Simpson gave evidence on his own behalf, denying that he ever accepted a ticket on the morning in question. He had not done so for some time, as he objected to accept tickets at all.

Mr. Green, for the defence, said that although there was a bye-law relative to the production of tickets to inspectors, there was no bye-law which compelled a passenger to take a ticket on boarding a car. The present case was one depending on the evidence, and not a question of law. The magistrates must either believe the conductor that Mr. Simpson took the ticket, or Mr. Simpson that he did not take it. Mr. Simpson objected to be made a servant of the Tramways Committee by accepting a ticket, and thus helping to check any carelessness or dishonesty on the part of conductors.

The Chairman said they were satisfied that the ticket was accepted, and that an offence had been committed. A fine of 20s. would be imposed.

A second case relating to May 22nd, in which the facts were similar, was then gone into. In this case Mr. Simpson was leaving the car when asked for his ticket, and he told the inspector he would find it somewhere on the top.

A fine of 10s. was imposed, and on the application of Mr. Green, the magistrates agreed to state a case.—*Nottingham Express.*

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Heating Lamps.

With reference to your note in your present issue respecting heating lamps, we are surprised to read the remarks in your last sentence to the effect that our "Sunbeam" radiator lamps have only been used for special purposes, and that, owing to the introduction of improvements, the use of this type of lamp has been practically discontinued.

This at once conveys to your readers a false impression, which, I trust, you will rectify immediately.

As a matter of fact, the company to whom you refer have had the sole rights of our lamps for some considerable time, and offered us several inducements to continue the arrangement.

We preferred, however, to give our many friends the benefit of our radiator lamp, which has proved so successful, and not to fasten ourselves exclusively to one firm.

That our action has been appreciated by the trade is assured from the fact that our sales are now three times the volume of last year, which, we think, sufficiently contradicts the statement you make that the use of this type of lamp has been discontinued.

We trust that you will make this clear in a further note on this subject, as you will quite see the detrimental effect of the position in which this is left as far as we are concerned.

The Sunbeam Lamp Co., Ltd.,
F. N. GRAINGER, *Secretary.*

Gateshead-on-Tyne, *June 9th*, 1905.

[As we stated, the information in our last issue was published on the authority of the Dowsing Co.—EDS. E.R.]

Municipal Electric Wiring.

The whole of the electrical trade are deeply indebted to you for your timely and powerful protest against the proposed clauses of the L.C.C. (General Powers) Bill now before Parliament.

It is hoped that attention will be thoroughly roused on this very important matter, and that your article will serve as a trumpet call to all engaged in the electrical industry.

The able and cogent manner in which you set out the ill effects that these powers would have on the whole of the trade emphasises, to a marked degree, the necessity for united action on the part of contractors, engineers and manufacturers.

I would suggest that the Contractors' Association and the Manufacturers' Association amalgamate to fight against the L.C.C. proposals, and that a joint guarantee fund be at once opened, and that all electrical firms throughout the country should be asked to contribute. It is to be deplored that joint action had not been decided upon earlier, but instant action must be taken to make up for the time already lost.

It is essential that united effort should be brought to bear to ensure any degree of success. The insidious character of the clauses under notice are sufficient to demand the instant attention of all those who desire to build up the electrical trade to a proper eminence among the industries of the country.

Joseph H. Evans.

Manchester,
June 12th, 1905.

Indication of Leakage and the Home Office Rules.

Mr. E. B. Vignoles contributes a most interesting *résumé* of some methods for the detection of leakage in mining installations to your issue of June 9th. In his anxiety, however, to show what *cannot* be done, he hardly, it seems to us, does justice to what *can*. As we read them, the new rules lay down: (1) That daily readings are to be taken and duly recorded, such that these readings will enable the engineer to determine whether or not the leakage current exceeds $\frac{1}{1000}$ of the working current; and (2) An indicator must be kept permanently connected up such that an earth on either main would be at once shown.

In spite of all Mr. Vignoles says, we cannot help maintaining that such a thing not only can, but is, being done.

The arrangements which he describes are, of course, somewhat crude, and are, no doubt, only intended to be taken as typical of the methods employed. This is, perhaps, unfortunate, as it is in the working out of the details of such instruments that their success or failure lies. Thus, for example, an instrument having so high a resistance, as must be the case with that shown in fig. 2, will be found to give much less satisfactory results than in one of lower resistance.

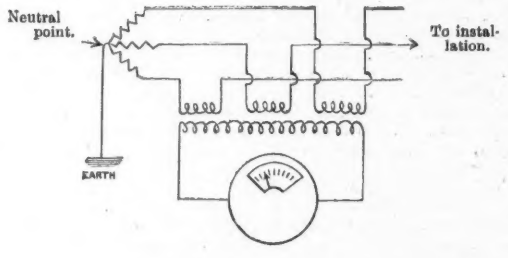
As regards the instrument shown in fig. 2, it is perfectly true that the deflections obtained only represent the relative leakage, and not the actual; but in practice this seems to be all that is required, as the instrument, being left continuously connected up, will at once show any decrease in the insulation of either main, and so draw the attention of the attendant to the fact. In our instruments we supplement this indicator by an electric bell, which is so set as to ring should a fault develop.

If, however, the *actual* leakage is required, and not merely the *relative*, all the data for obtaining this are at hand in the daily records, and it can be readily calculated from them. We mention this not because it is often required, but merely because it has been so frequently stated that the actual leakage cannot be obtained.

The term "leakage current," as used in the new mining regulations, has, so far as we are aware, never been defined. In the latest Board of Trade regulations "leakage current" is taken to mean the reading obtained on the earth ammeter, which is of precisely the same order as that obtained by the method under discussion. Presumably, however, the "leakage current" of the mining regulations is intended to represent the total current flowing out of one main into the other, *viâ* the earth, and as pointed out, this quantity is easily deduced from the readings.

The device shown in Mr. Vignoles' fig. 3, for three-phase insulated systems has been adopted by us at the suggestion of Mr. F. C. Raphael, and has, so far as we are aware, not before been used.

Mr. Vignoles does not allude to the case of three-phase systems with earthed neutral. Here again, the problem is an easy one, the only difficulties arising are over questions of detail. We ourselves adopt one of two alternative methods: (1) When the earthed neutral point is available we insert an earth ammeter in this circuit, duly protected from damage in case a short should occur. In this case also a bell draws the attention of the attendant to the fact. Further, by means of an artificial earth arrangement, it is possible to at once determine which main is the faulty one. (2) When the neutral point is not available, we employ a differential transformer arrangement, shown in the accompanying figure:



So long as all the mains are perfect, the primary currents will be equal, and there will be no flux in the core. Any leak, however, upsets the balance, and a deflection is produced on the instrument connected to the secondary. In this case also an artificial earthing arrangement enables the faulty main to be located.

Everett, Edgcumbe & Co., Ltd.
KENELM EDGCUMBE.

Westminster, S.W.
June 10th, 1905.

The Value of the A.M.I.E.E.

I am a country A.M.I.E.E., and am beginning to wonder what I get for the £2 2s. a year I send to the Institution.

The only return that I can see is the privilege (?) of signing myself A.M.I.E.E., and of receiving copies of the *Journal*, which I rarely read, by post.

Now, as to the benefit of the A.M.I.E.E., it has never been of the least use to me. Members when they require additions to their staff seem to prefer non-members, as they know that being a M. or A.M. of the Institution means nothing; in fact, prominent gas engineers who know even less about electrical engineering than they might be expected to know, and are notoriously (and naturally) antagonistic to electric light and power, are admitted as full members.

Also, many chief engineers of large concerns, including my chief, have never paid a penny to the Institution.

As regards the *Journal*, well, all papers of any practical use contained therein are printed in the technical journals.

The fact is, that the Institution is practically controlled by the London and more prominent country members in their own interest, as the ordinary country member cannot afford the time or the money to attend the meetings and vote.

I have been an Associate and Associate Member for over five years, and the only benefits I remember receiving for my 10 guineas are that I attended one meeting (but could not hear anything) and had a cup of coffee, &c.

I have conversed with other country members on this subject, and they all agree with me that either the subscriptions of the country members should be much reduced, or they should have substantial preference for vacant posts over non-members.

Also that applications for membership should be thoroughly gone into, and that only properly-trained and experienced electrical engineers should be admitted.

Anyway, if something is not done many country members, including myself, will resign their membership.

Provincial.

The Distributing System.

The views of "Omega," as given in a short article on "The Distributing System" in your last issue, are so entirely at variance with my own as expressed in a paper appearing in the *Journal*, Vol. 33, part 169, and reproduced in the REVIEW, that I am induced to offer a few remarks by way of criticism.

In the first place, the article referred to recommends a distinct contravention of one of the most recently drafted regulations of the Board of Trade, which stipulates that the network be as far as possible divided into feeder networks which may only be interconnected by means of fuses.

It has been my practice for some years to adopt the above method of interconnection with eminently satisfactory results, and I have no hesitation in saying that in the event of a serious short circuit, the value of the arrangement in limiting the area of interruption and minimising damage to cables cannot be over-estimated.

"Omega" objects to fuses on the score of crystallisation, &c., but in a properly designed system the equalising function of the fuse should not be very onerous, and in the event of the fuse failing an inequality of pressure of only a few volts would result.

The fuses can be examined when the boxes are periodically inspected, as rightly advocated by "Omega" although this inspection is hardly likely to prevent short circuits, which, in my experience, are generally produced by extraneous causes at any point of the network, the joint boxes being the most invulnerable.

As regards the testing of the mains during working, this is an extremely simple matter whatever system of mains may be employed, but this, again, is no safeguard against short-circuits.

The use of interconnecting fuses automatically assists very greatly in the localisation of a bad fault. In a correctly-sectioned network, where accurate key plans are kept, it is not infrequently possible to localise and eliminate a fault without consumers knowing of its existence.

The "column of smoke" method appears to me to be a barbarous expedient, to say nothing of the widespread damage to cables such a practice must entail.

I am hoping the article referred to will call forth remarks from others who, like myself, have had occasion to make the distributing system a special study.

W. E. Groves.

Birmingham, *June 13th*, 1905.

[The article in question was received and accepted by us before the new Regulations of the Board of Trade had been published.—EDS. E.R.]

The Mobus.

May I direct your attention to the no doubt interesting but absurd letter appearing under the above heading in your issue of the 9th inst.

"The good old London omnibus dribbles along the edge of the pavement"—says Mr. Raworth, and is, therefore, to be commended. Perhaps that style of progression may suit dribblers, but the man of to-day is—or should be—just as much in a hurry as the motor-'bus. No acrobatic performance is necessary either to mount or to alight. Passengers are picked up or set down in the usual way.

All the lines at present in full swing are not only earning more than the most sanguine promoter expected, but cannot get sufficient cars to meet the public demand.

Both the statements on costs made by Mr. Raworth are erroneous. But they are rather beside the question.

The suggestion that the motor-'bus should accommodate itself to the slow pace of the "travelling ark" is really too much. Let me direct Mr. Raworth's attention to our line, "The Vanguard." It does not matter what rate these 'buses are travelling at, he will always find them quick to stop at the usual signal—quicker than any horse 'bus. That is, of course, provided he is lucky enough to hail one not full up—their usual condition.

At the same time, the motor-'bus is coaching people to wait at appointed stopping places—not because it passes would-be passengers, but it is usually only possible to get a seat when someone alights at the end of their fare.

Anyway, I can assure Mr. Raworth that the proprietors are satisfied—it scarcely matters if he is not.

The reference to the elegant young man who drove the car on which Mr. Raworth travelled—what it was doing at Waterloo Station is another matter—is not only unkind, but a direct slander on Messrs. Tilling's drivers. I presume it was a Tilling car. It is certainly not worthy of the writer. Cheap ridicule will gain no more for the petrol 'bus's opponents than it has for the gas interest in connection with electric light.

I should very much have liked to have witnessed the remarkable performance to which Mr. Raworth refers. I mean the 'bus that slid 40 ft. with its wheels locked. Surely he was looking at an electric rail car.

Let me make a suggestion. There is practically only one method by which electric propulsion can compete against petrol and steam-driven vehicles. That is to equip similar vehicles with electric motors fed from overhead wires with flexible trolley connections. Should Mr. Raworth devote his attention to that and endeavour to perfect such a system, he would find it much more in his province.

That he knows nothing at all about the petrol 'bus is clearly shown by his suggestion that the driver's time and attention were absorbed by "his sparking plug and carburetter." Tut-tut!

Stuart A. Curzon.

London, S.W., *June 13th*, 1905.

THE DESIGN OF TRANSFORMERS.

BY A. PRESS.

IN designing transformers, if the avoidance of complicated calculation is sought, it will be necessary to start from an output equation. It will be observed if one has access to a range of designs that the rated kilo-volt-amperes bears in all cases a definite relation in practice to the gross volume of the iron laminations measured simply by the breadth, width and depth of the core body. In this relation the projecting portions of the windings beyond the core plates are apparently neglected. Thus, if the dimensions of a transformer are as indicated in fig. 1 on the next page, and W is the output in watts—

$$\frac{W}{h^3 \cdot 2\,b \cdot c} = \frac{W^{\frac{1}{3}}}{55} \quad \ldots \quad \ldots \quad (1)$$

This proposed output formula has been obtained empirically, and represents a rule covering *various* designs from 5 KW. to 1,000 KW. It applies to shell type as well as to core type, and to single-phase as well as to polyphase. Fifty cycles is, however, premised. From equation (1) the value of h can be obtained provided the magnitudes of b and c are settled upon, and the equation then takes the more convenient form—

$$h = \frac{14 \times \text{KVA}^{\frac{1}{3}}}{\left(b \times c \times \text{KVA}^{\frac{1}{3}}\right)^{\frac{1}{3}}} \quad \ldots \quad (2)$$

All dimensions are in centimetres. The values of a, b and c are entirely arbitrary, but a relation can be found between them that shall make the losses a minimum for a given output, provided a and b, the magnetic density B, and the frequency are kept constant. If c alone is varied, increasing c first diminishes the copper loss because more flux is being used, but, of course, the iron loss will be continually increasing. In this manner, although the total losses are at first made smaller, there soon arrives a time when increasing

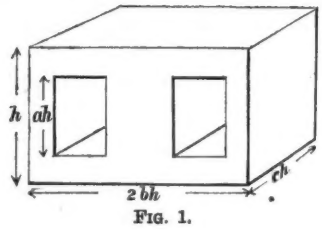


FIG. 1.

c so increases the iron loss that even with a greatly reduced copper loss, the total losses are much larger than under former conditions. The copper loss can be represented absolutely, from geometrical considerations, &c., by $J^2 \Omega = x\,y$ where x depends upon the magnetic density, frequency, output, &c., and y is a factor simply depending on a, b and c. The shell type is throughout postulated. The value of y is given by—

$$y = \frac{c - \cdot 57\,(1 - a) + 1 \cdot 57\,b}{c^2} = \frac{c + K}{c^2} \quad (3)$$

and x is given by—

$$x = \frac{8 \cdot 1 \times 10^9 \times W^2}{\phi\, h^5\, a\,(a + b - 1)\,\{B \,.\, i \,.\, v \,.\, f\,(1 - a)\}^2}. \quad (4)$$

Here i = iron factor (about ·9).

f = frequency.

v = ventilating factor. For unventilated cores where the spacing is 0 per cent. the factor v would be unity.

ϕ = copper factor expressing ratio of net copper cross-section to total available winding cross-section. Its value is about ·3.

The specific resistance of copper per cm.^{3} has been taken as 2×10^{-6} ohms. In this manner, furthermore, the iron loss in watts can be expressed analytically by—

$$\text{Iron loss} = 3 \cdot 9 \times 10^{-11} \times f^{1 \cdot 27}\, B^{1 \cdot 65}\, c\, h^3\,(1 - a)\,\{2 \cdot 43\,a + 2\,b - \cdot 43\}\, i\, v. \quad \ldots \quad (5)$$

In this expression, for which will be substituted $I = u\,v$, since the investigation will be conducted for $\frac{d}{d\,c} = 0$, the value of v in the iron loss will be taken as c. Thus—

$$I = u \,.\, c \text{ and } J^2 \Omega = \frac{x\,(c + K)}{c^2}. \quad \ldots \quad (6)$$

If we agree to have the iron loss m times as great as the copper loss, operating upon equations (6) with $\frac{d}{d\,c} = 0$, the following equation results—

$$c = \left(\frac{2 - m}{m - 1}\right)\{1 \cdot 57\,b - \cdot 57\,(1 - a)\}. \quad (7)$$

This is the condition for c that minimum iron and copper losses may occur. Evidently equation (7) is only applicable when the value of m is taken between the values 1 and 2. A good value is 1·5, and then—

$$c = 1 \cdot 57\,b - \cdot 57\,(1 - a). \quad \ldots \quad (8)$$

Keeping everything constant except the value of the frequency, the copper loss in the transformer windings will vary inversely as the square of the frequency. This conclusion is easily arrived at from the equation for voltage in terms of flux, frequency and turns. On the other hand, by equation (5) it is easily seen that the iron loss varies as the frequency to the 1·27th power. Thus investigating for minimum iron and copper loss—

$$\frac{d}{d\,f}\left(\frac{P}{f^2} + Q\,f^{1 \cdot 27}\right) = 0$$

gives

$$\text{Iron loss} = 1 \cdot 57 \times \text{copper loss}. \quad \ldots \quad (9)$$

Thus m should be in the neighbourhood of 1·57. If the differentiation had been conducted toward determining the best value of B, the value of m resulting would have been 1·21. This latter value inserted in equation (7) gives rather larger values for c than is usually the case in practice. Too long cores would mean greater heating internally, due to the copper loss. The result would show itself in a possible "ageing" of the iron, and for this reason the value of m had been suggested as 1·5.

A graphic view is given of equation (8) in fig. 2. The values of c are plotted perpendicularly for values of a horizontally, the different curves expressing the relation for different b's.

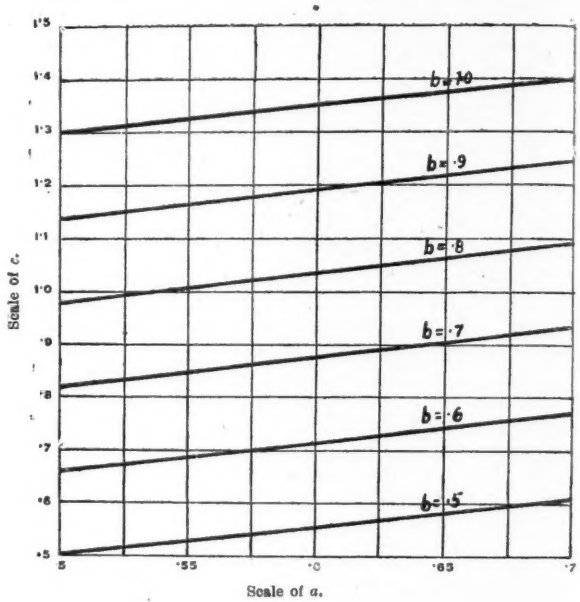


FIG. 2.

It is thus seen that practically deciding on b implies a given value for c irrespective of a. A mean value of a in shell type transformers is ·6. Thus with a given b and, therefore, c, the value of h follows from the output equation (2). There is then left to determine the value of B. This is done by equating the analytical value for the iron loss to m times the copper loss. It will be seen that in the two equations for the losses the only unknown is B, and its value can be quite easily evaluated by means of the slide rule. Knowing thus the iron and copper losses the efficiency is known, but as a check for the proper assumptions for the values of a and b the current density in the copper should be investigated. Analytically it is given by the following—

$$\text{Current density} = \left(\frac{\text{amp.}}{\text{cm.}^2}\right) = \frac{4 \cdot 55 \times 10^7 \times W}{\varphi \,.\, i\, v \,.\, B \,.\, f \,.\, h^4\, a\, c\,(1 - a)\,(a + b - 1)}. \quad (10)$$

The usual current densities obtaining are 100 amperes per square centimetre for transformers with unaided ventilation, and about 150 amperes for those with forced.

A WORKMAN'S INVENTION.

[By Our Legal Contributor.]

CERTAIN letters which have recently appeared in the columns of the REVIEW have led us to think that, in spite of the fact that we have previously dealt with the question as to how far an employer is entitled to claim the benefit of his workman's inventions, there is considerable doubt upon the question.

It would be difficult, in the compass of a short article, to propound and answer all the questions which may arise in

connection with the right of a master to claim the benefit of his workman's inventive genius. While working at his lathe, in the foundry, or in the laboratory, numerous little contrivances may suggest themselves to the mind of the skilful workman. He may be employed to carry out a certain process, and in the course of his manipulations he may discover a short cut to the final result, which short cut may be made the subject of a very valuable patent. Is he bound to disclose and hand over his invention to his employer, or may he take out a patent in his own name, although his invention was the direct result of his employment in his employer's time and with his employer's materials?

To begin with, setting aside for the moment the problems which arise upon the ordinary relationship of master and servant, it may be regarded as settled law that where an inventor employs others to work out the details of his invention, the modifications, &c., which they may suggest are the property of the employer. In a case which was heard some years ago, this principle was applied to the refusal of a patent to the employé on the opposition of his employer.

It will be conceded that the principle is the embodiment of common sense. If a man is seized with an idea, but has not the mechanical skill to carry it out, he must necessarily employ others to assist him. If he were to sacrifice the prospect of being able to obtain a monopoly by calling in persons to assist him, it is difficult to see how any man who had no mechanical skill, could ever hope to perfect an invention. But suppose that, while so employed, the workman were to leave his master's service and were to apply for a patent for the invention in question in his own name. In such a case, if it could be shown that the workman was acting honestly, the Court would probably make a grant of the patent to hold the same in trust for the benefit of the workman and his employer.

The ordinary contract of employment does not, however, *per se* entitle a master to the benefit of inventions worked out and patented by his servant, although it may be proved (1) that the invention is one which is connected with the employer's business; (2) that it has been worked out in the employer's time and with the employer's materials; and (3) that the servant has allowed the employer to use it during the term. Let us consider a few of the cases which throw light upon the question whether the employer becomes entitled by implication to the inventions of his workman. In Allen *v.* Rawson (1845) 1 C.B. 551, Tindal, C.T., thus expresses himself:—

"It would be difficult to define how far the suggestions of a workman employed in the construction of a machine are to be considered as distinct inventions by him, so as to render void a patent incorporating them when taken out by his employer. Each case must depend upon its own merits. But when we see that the principle and object of the invention are complete without it, I think it is too much that a suggestion of a workman employed in the course of experiments of something calculated more easily to carry into effect the conceptions of the inventor should render the whole patent void."

When a servant filed a provisional specification for an invention, after which the master filed a provisional specification for a similar invention, and subsequently filed a complete specification and obtained letters patent, it was held that the great seal might be affixed to the letters patent for the servant's invention, and that the letters patent might bear the date of his provisional specification. (Exp. Scott & Young, L.R., 6, Ch. 274.) But an employer is not entitled to the inventions of his servants, but is only entitled to embody improvements made or suggested by them when employed to perfect and carry out an invention. If he adopts suggestions which are essential to his invention, and which come within the principle and object of that invention, then he is no longer the "true" inventor.

In Bloxham *v.* Elsee, 1 C. & P. 558, an engineer employed by the patentee gave professional assistance, and suggested several mechanical parts of the machine which formed the subject of the patent, but the main invention was exclusively that of the patentee, who was held to be the true inventor. In Tennant's case (1 W.P.C. 125 n), however, a patent for a bleaching preparation was declared to be invalid because the patentee had been assisted by a chemist, who had enabled him to arrive at a main portion of the invention. It seemed that the chemist had pointed out to the patentee that the end desired would be attained if the lime water in the bleaching liquor were constantly agitated, and this turned out to be so.

In another case it appeared that the patentee had been told of a particular roller, part of the machinery, by one Kay, and perceiving the value of the invention, he took Kay into his service for two years, employed him in making models, and subsequently applied for and obtained a patent for the invention of his own. In the same way he obtained and adopted a peculiar form of crank, which was invented by another man. At the trial he was declared not to have been the true and first inventor.

Lastly, in a case which was decided in 1823, it was decided that if the invention is wholly or in part the work of a servant, the master cannot get a patent alone, if at all. When a man obtains information to the effect that a workman has knowledge of a particular invention, he cannot by merely taking that workman into his service annex that invention so as to become "the first and true inventor."

The rights of an employer, who occupies a position much higher than that of a mere workman, must apparently be ascertained in accordance with the foregoing principles—that is to say, where the agreement is silent, the rights of the parties must be ascertained by reference to all the facts of the case. In a case which was heard in the Chancery Division in 1902, an action was brought by an engineering company, who claimed a declaration that certain patents taken out by an ex-manager were the property of the company, and that the patentee was merely entitled to hold the same in trust on behalf of the company. It appeared that the company had for many years been manufacturers and importers of a particular machine, in connection with which they were the holders of certain patents. The defendant, who had held a position as their manager in England for a number of years, was well versed in the business of the company, but there was nothing in his agreement with them to show that he was bound to hand over all his inventions to them, nor was there anything to show that the company was entitled to the benefit of every invention which he or any of its employés might acquire. Mr. Justice Byrne, in giving judgement, said: "I recognise, and quite appreciate, the principle of those cases, which have established that the mere existence of a contract of service does not, *per se*, disqualify a servant from taking out a patent for an invention made by him during his term of service, even though the invention may relate to subject matter germane to, and useful for, his employers in their business, and even though the servant may have made use of his employer's time and servants and materials in bringing his invention to completion, and may have allowed his employers to use the invention while in their employment; but, on the other hand, without repeating what has been so fully and admirably expressed by the Court of Appeal in Lamb *v.* Evans and Robb *v.* Green, it is clear that all the circumstances must be considered in each case. I consider that . . . it is impossible to say in the present case that the defendant has established the right he claims, having regard to the obligation arising from his contract of service, and I am of opinion that his case is inconsistent with an observance of that good faith which ought properly to be inferred or implied as an obligation from his contract."

COMPARATIVE TESTS OF STEAM AND ELECTRIC LOCOMOTIVES.

In the *Scientific American* of May 20th, 1905, some interesting data are given in connection with a series of comparative tests carried out at the end of last April on the most powerful express steam locomotive owned by the New York Central Railroad Co., and a new electric locomotive which is intended for the electrified portion of their lines. The steam locomotive has cylinders 22 in. × 26 in., the total weight being given as 342,000 lb., or approximately 152½ English tons. The electric locomotive is considerably lighter, the

approximate weight being 200,500 lb., or approximately 89½ tons. Each locomotive was coupled to an eight-car train, the cars being loaded up so as to make the total weights of the trains practically equal, namely, 513 tons. The electric train, therefore, exclusive of locomotive, was 63 tons heavier than the train drawn by the steam locomotive.

The experimental track is six miles in length, and the working conductor consists of a top-contact 70-lb. steel rail, reinforced with copper. Current was supplied from the General Electric Co.'s plant at Schenectady, the energy being transmitted at 11,000 volts and transformed down to 700 volts at the sub-stations, the live rail voltage being about 475. The tests show the importance of maintaining the pressure as near as possible to the normal, as, owing to the excessive drop during acceleration, the electric train was severely handicapped.

Thus, in the first run, both trains starting together, the steam locomotive accelerated faster than the electric locomotive, owing to an abnormal drop in the voltage from 700 at the sub-station to about 325 on the rail. At 3,000 ft. from the starting point, however, the electric locomotive acquired the same speed as the steam locomotive, and accelerated more rapidly from that point, passing the steam locomotive at a distance of two miles from the starting point, and finishing up two train lengths ahead.

The maximum speeds attained were 50 miles an hour for the steam locomotive, and 57 miles an hour for the electric.

In a subsequent test under the same conditions the relative speeds were 53·6 and 60 miles per hour respectively. In order to compare the results under conditions approaching more nearly to those which ought to occur in practice, another test was made with a 6-car train, the approximate total weights being about 410 tons, and the trains starting at a point nearer to the sub-station so as to ensure a higher voltage. Under these conditions the electric locomotive, from the first turn of the wheels, accelerated faster than the steam locomotive, and at 1,500 ft. from the starting point the electric train led by a full train length. What is called the revenue-bearing load behind the locomotive is given in this test as 256 tons for the steam and 307·25 for the electric, a difference of 51·25 in favour of the latter. The time required to reach a speed of 50 miles per hour was for the steam train 203 seconds and for the electric 127, the average acceleration up to 50 m.p.h. being respectively 0·245 and 0·394 mile per hour per second. The latter figure corresponds to an acceleration of 0·577 ft. per second per second.

In order to test the maximum speed, the electric locomotive was run light and attained the maximum of 80·2 miles an hour, and it is believed that it could have reached 90 miles per hour had it not been necessary to shut off current on the curves.

On May 1st a maximum speed of 85 m.p.h., with a limitation of 78 m.p.h. on the 2 degree 17-minute curve, was reached.

ADVICE TO YOUNG ENGINEERS.

It is the last luxury of the successful man to tender benevolent advice to the struggling aspirant beneath him. Sometimes it is in essence a kick at the ladder which raised him, but in any case it must be uncommonly good counsel to escape the carpings of the juniors, who always prefer "bread and circuses" to philosophic disquisitions. Electrical engineers, however, are remarkably well off for fatherly counsel. The recent advice of Mr. Swinburne to the students of the Institution of Electrical Engineers will be within the recollection of our readers, and now wisdom comes from over the water. In the *Wisconsin Engineer* for the present month a good article by Mr. C. H. Williams bears a most remarkable resemblance to the friendly counsel of Mr. Swinburne. Considerations of space forbid us to print the paper in full, but we may extract therefrom two anecdotes and some aphorisms. The first story illustrates the value of reciprocity in the exchange of practical and theoretical knowledge by students and workmen:—

"The local electric plant took on a recent graduate who had carried on considerable practical work along the line of analysing flue gases which escape from the stacks of boilers.

"His first work with the company was along this line, with the hope that the operation of the station boilers would be improved and their efficiency increased. To best obtain these results, he made a study first of the men who were at that time handling the work. He became perfectly familiar with the methods of which they were making use, then brought them to a thorough understanding of what takes place within the furnaces when the fuel burns. After this had been accomplished (which took about three weeks), he introduced an Orsat apparatus, and after explaining its working to the men, he had them use it, and they analysed the gas. The tests they made at first, of course, were crude, but they made them all themselves, and they saw the results improve. By this time the men were thoroughly alive to the interest of the matter, and instead of considering themselves simply tools to carry out the work of someone else, they were engineers doing scientific and practical engineering work themselves.

"A keen rivalry was established among the operators; they were working for results and obtained them, because they knew how to obtain them. The results were, that for the year following this work the fuel costs decreased 6·8 per cent. on 7,500 tons of coal in a year, with coal at that time costing practically $4.00 a ton; this result to the employing company.

"The result to the man was that the company found that they needed just such another man for another place, and a better position elsewhere was found, and he was given it."

The second anecdote shows the importance of a commercial training and broad views to a manager:—

"A manager in a central station gas plant found it necessary to bring about a reduction in the net cost of the gas made at his plant, due to the rapidly changing commercial conditions in the district in which his plant was operating, for continued strikes and consequent limited supply of coal had materially raised the price of the raw material.

"Every effort was made by him along the lines in which he had received his training (he having worked his way by persistent efforts up through the manufacturing end of the business to the position of manager) to meet the increased cost of materials by a decreased cost of manufacture, but this appeared to him impossible to do.

"The inevitable result obtained, and he was transferred to another field, where a specialist was needed in the manufacturing end alone, and in filling his position a man was selected who had been trained in a commercial way first, and later in engineering work.

"Viewing the matter in a broad sense, the successor saw that there was small chance of cutting the costs of manufacture, but, nevertheless, he at once saw possibilities which were sufficient for the case in hand.

"The plant referred to was a coal gas plant, and, although the sales of gas were large, they had never cultivated a market for their coke, which is the by-product obtained after distilling the gas from the coal.

"Statistics showed the manager that towns of the same size, and located under like conditions, offered a ready market for more coke than the plant produced, whereas for years the receipts from this source had been practically nothing. The condition of the fuel market was such (due to labour troubles) that people were only too anxious to obtain a satisfactory substitute for coal, and before three months had passed, a demand had been established, the coke sold at the price of coal, receipts credited to the manufacturing costs, and the business again placed on a satisfactory basis."

The moral of the above stories is deduced in such fringent language that the salt would lose its savour if any other words were used:—

"If you look round the electrical industry, or round the industries generally, who are at the top? Always the business man. The men at the head of large industries generally know very little science. A man may run a large electrical industry with the most vague ideas as to the true relation of the electrostatic and electromagnetic systems of units; in fact, he may think power, force and energy are very much the same kind of thing, if looked at in a broad, common-sense way without any scientific prejudice.

"If he wants good technologists he employs them. If he wants practical men who can take commercial responsibility he pays good salaries; but if he wants men full of book knowledge he pays low salaries; but he does not generally want them.

"We see, then, that the business man is the master, the engineer is his good slave, and the raw scientist is not good enough even to be the slave of the engineer; he has no market value at all. The raw scientist will remain at the bottom of the tree until he gets rid of the professional cant which pretends that raw science is pure, or nobler and superior to science as a whole; and the engineer will remain in the middle position as long as he takes the middle view, and considers engineering as something superior to money considerations, and as long as he looks down on business and commercial methods."

These statements are, unfortunately, true. Everything in engineering can be ultimately reduced to pounds, shillings and pence; and it is the man who can solve problems to these terms who is able to extract the largest moiety therefrom for himself. But we would raise a larger question. Is not the very abundance of such good advice rather an abnormal symptom? Does it not point to the fact that either the conditions of employment in electrical engineering are becoming day by day more onerous, or else that our juniors enter the ranks with exaggerated ideas of their powers of progression? We are inclined to think that such counsel is the outcome of a spirit of restlessness among subordinates due to a generally unsatisfied state of mind, and we think that only rigid adherence to common sense will prevent the majority of us from passing the bulk of our days in discontent. Times have changed since the early days. There was then, so to speak, a vacuum in the industrial market, whose demand absorbed engineers and placed them in good positions as quickly as they entered the electrical zone. Now there is a plenum, and good positions are gained only by hard self-pushing or the external pressure known as "influence."

The days of quick changes are, perhaps fortunately, past. The

best course at present for a young engineer appears to be to attach himself to a good firm and identify its interests with his own, trusting that with the development of that firm's business his share in the general success will be recognised, and that he will be gradually carried forward to more responsibility as vacancies occur. We would recommend to all whom it may concern the creed of a very successful engineer in a good position, who once defined his ideas to us as follows:—

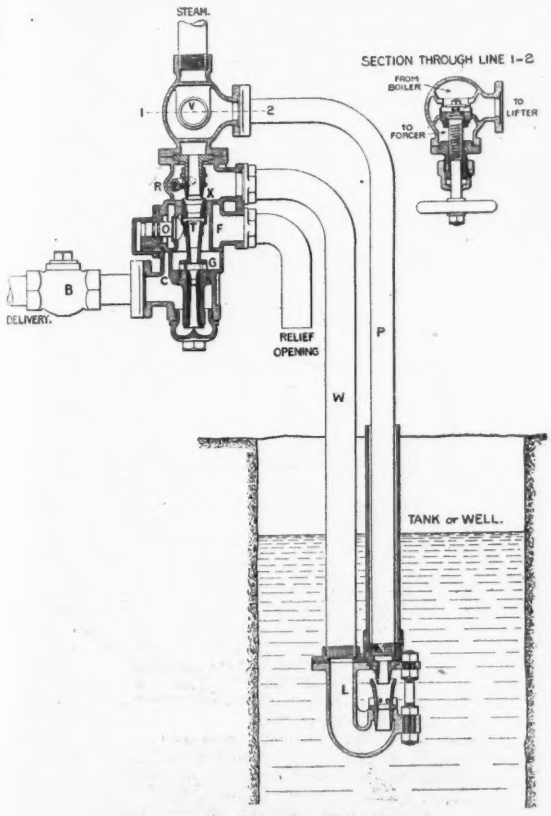
"Proposition 1.—I am here.

"Proposition 2.—When I leave, the flag will be half-mast.

"Proposition 3.—All the rest of you can go to your proper destinations."

BUSINESS NOTES.

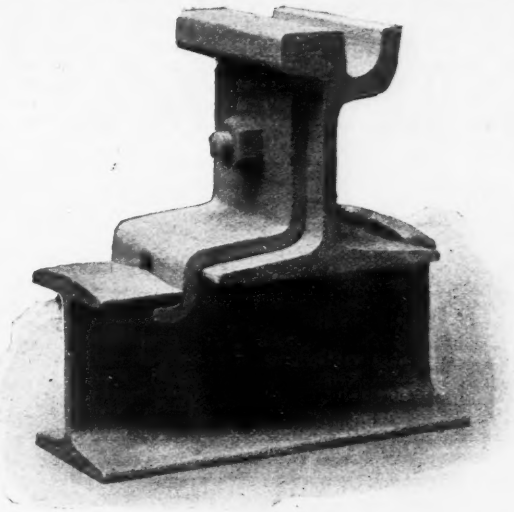
Albion Patent Boiler Feeder.—This apparatus is a combination of two jet instruments, connected in series with a three-way operating valve intended to control the supply of steam to the other two component parts. In the accompanying cross section, L represents the lifter portion, connected by the pipe W to the water inlet of the forcer, which is represented by F. The steam-operating valve V is so constructed that it will not admit steam to the forcer cones until the valve is opened full, whilst steam is allowed to pass through the pipe P to the lifter immediately the valve is being raised off its seating. As both the opening full of the valve and the raising of the water to the forcer by means of the lifter are only a matter of a few moments, the steam from the forcer steam cone and the water from the lifter will arrive at X nearly simultaneously. The action is positive, as the water is forced up from the feed tank or well by the motive power of steam; it is delivered to the forcer at a fairly high temperature, and is further heated whilst passing through the forcer. The feed enters the delivery pipe through the back-pressure valve B at a temperature varying, according to



The Albion Boiler Feeder.

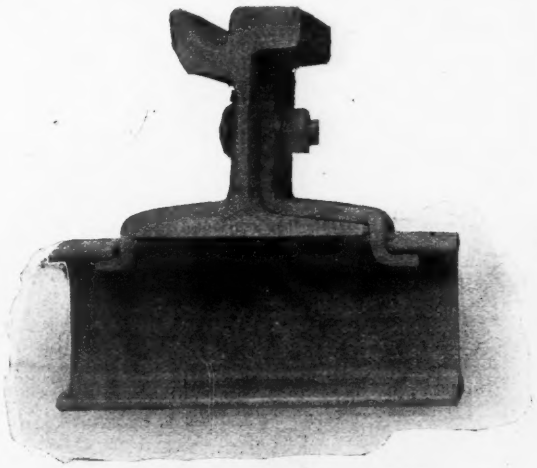
circumstances, up to 300° F. To allow the water to pass the open gap G in the combining cone T of the forcer, some means had to be devised to keep the pressure surrounding the jet at this point always in excess of that pressure which corresponds to the temperature of the passing water. The pressure set up by the jets of the apparatus was utilised for this purpose. Valve O is firmly held upon its seating through this pressure acting by way of the by-pass C upon the top of it, and thus closes the relief passage F leading to the atmosphere. The apparatus is perfectly self-regulating for varying boiler pressures. A regulator R is provided to regulate the amount of feed delivered to the boiler by increasing or decreasing the water area at will. In general, this boiler feeder takes hotter water than others under the same working conditions, and starts instantaneously, even if the water-pipe and the feed-water are hot; it will lift and force the water to boiler out of a well 50 or even 100 ft. deep. The apparatus is made only by the inventors, the Albion Engineering Co., Ltd., Manchester.

The "Ratqua" Rail Anchors.—These rail anchors, for which patents are pending, will readily commend themselves to engineers and contractors engaged upon tramway or similar works where girder rails are to be used. Both anchors are cheap, simple and efficient as a means of anchoring down the rails. The "Ratqua



The "Ratqua" No. 1 Rail Anchor.

No. 1" anchor consists of a foundation plate in the form of a H iron, the top flange of which at one end is turned up and over to make a forked grip on the bottom flange of the girder rail, the other end being slotted to take the fork of the "locking plate." The latter is a plate formed so as to fit the outside of the girder rail, and when "locked" into the slot of the H iron, is bolted with a single bolt to the web of the rail. The tighter this "locking" plate is bolted up, the tighter the grip of the anchor on the rail. The "Ratqua No. 2" anchor consists of a foundation plate in the form of an H iron, the top flange of which is slotted at both ends. It carries two "locking plates," one on either side of the rail, both of which are bolted up to the rail web by a single bolt. This type of anchor is sometimes favoured owing to the extra stiffness it gives to



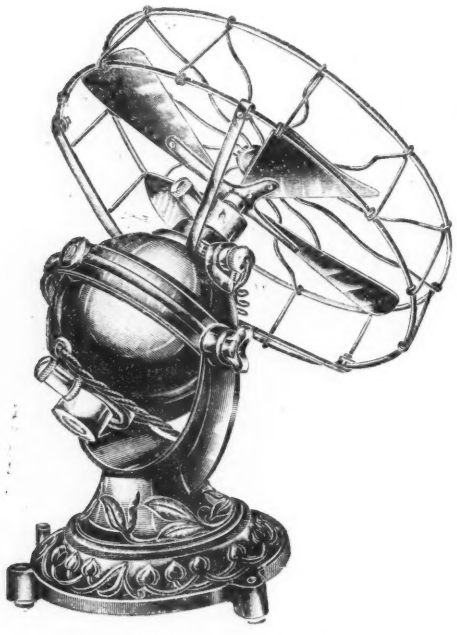
The "Ratqua" No. 2 Rail Anchor.

the rail web. The great advantage of both types is that a rail can be taken out and replaced by simply removing the "locking plates," which operation in no way disturbs or shakes the H iron plate in the concrete foundation. The anchors, shown above, are for use as intermediate anchors in tramway tracks where sole-plates are used at joints, and where welded joints are adopted, and are not put forward as rail-joint anchors. The No. 2 anchor is especially recommended for use on an existing track which has been laid without anchors and is showing signs of "pumping"; it is, in fact, the only anchor that can be put in a track whilst car traffic is continued, and give absolute satisfaction. Messrs. Hurst, Nelson and Co., of Motherwell, who are the sole manufacturers for the "Ratqua" Rail Anchors, of 4, Victoria Terrace, Edinburgh, have provided special plant for the making of these anchors and "locking plates," and can supply large quantities on very short notice.

Imports of Foreign Electrical Machinery.—A slight easing off in the importation of foreign electrical machinery into this country occurred during May last, the value—£29,477—being

the smallest monthly total so far recorded, and comparing with £51,064 in April last, and £35,887 in May, 1904. For the first five months of the year the imports have attained a total of only £207,039, as contrasted with £214,811 in the corresponding period of last year, and £260,505 in the first five months of 1903.

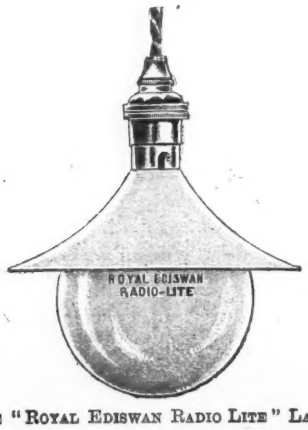
The Stellite A.P. Fan.—The Stellite A.P. fan, which is here illustrated, is equally suitable for use on the table, wall, or ceiling. It has been specially designed to meet Admiralty requirements, and is guaranteed mechanically and electrically sound. The frame is fitted with a gimbal ring, while the joints have brass fittings and phosphor bronze bearings. The gimbal arrangement permits the fan to be turned about, so that a current of air may be sent in any required direction. A three-speed



THE STELLITE A.P. FAN.

starting switch is fitted in the pedestal, with a spring catch position for each speed, and the starting lever is thoroughly insulated; a substantial brass guard is fitted, and self-regulating carbon brushes and self-oiling bearings are also among the details of these little fans. The ELECTRIC AND ORDNANCE ACCESSORIES CO., LTD., of Stellite Works, Birmingham, who are placing this fan on the market at an exceedingly low price, have numerous agencies throughout Great Britain, also in South Africa, India, China, South America, &c.

The "Royal Ediswan Radio-Lite" Lamp.—THE EDISON & SWAN UNITED ELECTRIC LIGHT CO., LTD., of Ediswan Buildings, Cheapside, E.C., have introduced the "Royal Ediswan Radio-Lite" lamp, as here illustrated, in order to meet the growing demand for a special form of spherical-shaped electric lamp. It is



THE "ROYAL EDISWAN RADIO LITE" LAMP.

manufactured in two sizes, for any voltage from 100 to 250. The bulb diameters are 4 and 5 in., giving a downward reflection of 40-50 and 80-90 C.P. respectively. The lamp gives a beautiful soft, bright light, specially suitable for shop lighting, corridors, institutions, house lighting, &c. It is claimed to be the best of its kind on the market, and we understand that great difficulty has been experienced in meeting the numerous orders in hand for it.

Installation Contracts.—MESSRS. W. P. THEERMANN AND CO., of Manchester, have recently booked the following contracts:—

For the Broadstone Spinning Co., Ltd., Stockport.—A 100-KW. coupled plant and 1,350 lights.

For the Royal and Grand Theatre Co., Bolton.—Two 75-H.P. gas engines with gas producers, dynamos and accumulators, and 1,600 lights.

For the Theatre Royal Co. Ltd., Darlington.—A gas engine and dynamo and 600 lights.

For the Goyt Spinning Co., Ltd., Marple.—A steam engine, three dynamos, and 1,400 lights.

For the Monton Spinning Co., Ltd., Eccles.—Three dynamos and steam engine, and 1,050 lights.

For the Togo Spinning Co., Ltd., Patricroft.—Three dynamos, steam engine, and 1,400 lights.

For the Byrom Dyeing Co., Ltd., Bacup.—Dynamos and 220 lights.

The following contracts have recently been completed by Mr. RALPH NANCE, of Cardiff:—

Mountain Ash Market Hall and Pavilion; Mountain Ash, Glam.—Complete electric light installation, consisting of 18-B.H.P. "Cundall" oil engine, General Electric Co.'s dynamo, driven direct from the oil engine, which has been specially built with extra heavy fly-wheels, Johnson & Phillips arc lamps and incandescent lighting.

Anchor House Residence and Drapery Establishment, Ebbw Vale.—Complete installation, consisting of 10-B.H.P. "Cundall" oil engine, "Webster" dynamo, "Ediswan" switchboard, "A.B.P." storage battery, and about 100 incandescent lamps.

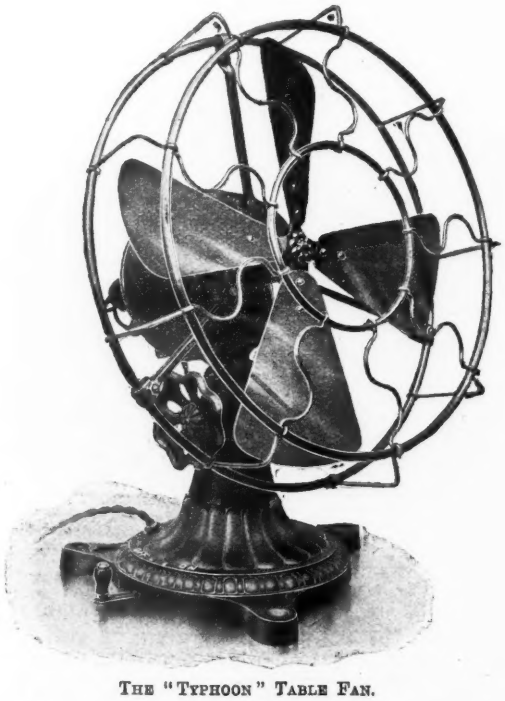
Tidenham House, Tidenham, Glos.—Complete electric light installation, consisting of 10-B.H.P. "Cundall" oil engine, "Webster" dynamo, "Ediswan" switchboard, "A.B.P." storage battery, and about 100 incandescent lamps in residence, stables and outhouses, laundry, &c.

Barry Urban District Council, Glam.—Supplying and laying about 700 yards of armoured cable from destructor to technical schools, and supplying and fixing "Webster" motors at technical school to drive fitting shop machinery.

Dan-y-Bryn and Frondeg, Radyr, near Cardiff.—Complete installation, consisting of 20-B.H.P. "Cundall" gas engine and patent suction gas producer (worked at a cost of 2d. per hour at full load), "Webster" generator, Wednesbury white marble switchboard, "A.B.P." battery (110 cells), underground mains Dan-y-Bryn is wired and fitted with 150 incandescent lights, and Frondeg i fitted with 90 lights, and about 50 lights in cottages, conservatories, outs houses, &c.

Switchgear Contracts.—MESSRS. BERRY, SKINNER AND CO. have recently secured the following contracts for Berry's patent ironclad switchgear:—London Electric Supply Co., Ltd., 50 sets; Maidstone Corporation, 100 sets; Govan Corporation, 12 months' supply; Swindon U.D.C., 12 months' supply; Norwich Corporation, 100 sets; Birmingham Corporation, 144 sets.

The "Typhoon" Table Fan.—The "Typhoon" fans form one of the many varieties of electrical apparatus turned out by MESSRS. VERITYS, LTD., of Aston, Birmingham. These fans, following the prevailing fashion, can be adapted at will for table, wall, or ceiling use, being provided with a patent knuckle joint for tilting, and a swivelling joint, thus allowing the fan to be set to



THE "TYPHOON" TABLE FAN.

blow in any desired direction. The motor is of the well-known "Aston" type, and a three-speed regulator is arranged in the base of the fan. The base is substantially made—three spreading feet being provided, and, as a whole, the motor and base are finished in black and gold enamel, the blades being bronzed. The firm build many varieties of fans for domestic and trade purposes, which are adapted as desired for either direct or alternating current circuits.

Natal.—The value of the electrical fittings imported into Natal during the three months ending with March last is officially returned at £9,000, as compared with only £8,000 in the corresponding quarter of 1904.

Stoker Contracts. — The following contracts have recently been booked by MESSRS. EDWARD BENNIS & CO., LTD., of Little Hulton, Bolton:—

Blackpool Corporation, two Bennis patent stokers and self-cleaning compressed air furnaces for Lancashire boiler, and automatic steam regulator.

Burton-on-Trent Corporation, four Bennis patent machine stokers and new patent self-cleaning compressed air furnaces.

Northampton, for the Northampton Electric Light and Power Co., complete coal ash elevating and conveying plant, coal bunkers, &c. (£862).

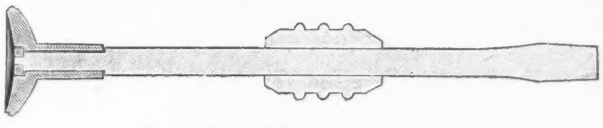
Hammersmith Borough Council, Electricity Department, complete coal and ash elevator conveyor plant (£747).

Portsmouth Dockyard Power Station, 20 Bennis stokers and furnaces shafting gear, &c. (through Messrs. Edwin Danks & Co. (Oldbury), Ltd.

For Sale.—On June 23rd, MESSRS. P. HUDDLESTON AND CO. will sell by auction at Hammersmith a quantity of electrical apparatus. On 28th inst. the same firm will offer a complete electrical installation at High Barnet. Particulars of both sales appear among our advertisements to-day.

Large Increases in Imports and Exports.—Comparison of last month's Board of Trade trade returns with those of the corresponding period is complicated by the fact that May, 1904, contained an extra Sunday, and was also affected by the Whit holidays. Nevertheless, as they stand, the figures are very satisfactory, the imports, including bullion, showing an increase of £2,326,000 over last year, and of £5,610,000 over May, 1903. The exports are £3,500,000 ahead of last year, and £4,780,000 higher than 1903. For the five months, the returns are still better, especially as compared with two years ago, imports being £17,560,000 higher, and exports £18,406,000 higher.—*Pall Mall Gazette.*

Electrician's Screwdriver.—Mr. W. MARSHALL, of 72, Oxford Street, Manchester, has sent us a sample of his newly-designed screwdriver for the use of electrician instrument makers and others. It is somewhat similar to the tool used by watchmakers, but of a much stronger pattern. The revolving head is a useful feature, as, by placing the point of the index finger in the hollowed part of the loose head, and the blade of the screwdriver in



SECTION OF "W.O.A." SCREWDRIVER.

the slot of a screw, it may be twirled rapidly between the thumb and second finger by means of the knurled boss in the centre. Should the screw be too tight a fit for this, the instrument may be held with the loose head pressed against the inside of the knuckle of the first finger, and the screwdriver turned by the finger and thumb as before, the extra purchase making it easy to prevent it from slipping out of the slot of the screw. The illustration is a full size section; the design is registered. It is known as the "W.O.A." screwdriver, these letters being the initials of the designer, who is an electrical man. The whole article is British made.

Book Notices.—*Manuale dell' Ingegnere Elettricista*, per Attilio Marro. Milan: Ulrico Hoepli. 1905. Price L. 7.50. It is an unfortunate fact that the British engineers who are acquainted with the Italian language are in a very small minority. This is the more to be regretted in view of the excellent articles and treatises on engineering matters now published in that language, and of the admirable works which have been carried out by Italian engineers. Moreover, to those who retain a smattering of Latin from their schooldays, and are familiar with French, the language of Italy is remarkably easy to master sufficiently for practical purposes. In this pocket-book, one of the 800 "Manuali Hoepli"—a series of scientific, technical and educational works comprising a library in itself—the reader has a handy reference book of nearly 700 pages, covering all branches of electro-technology in brief. There are numerous articles on the theory and practice of electrical engineering, diagrams and tables galore, and a fairly complete index. The book opens in the rational way, like an ordinary volume, is well printed and strongly bound, and is sure to meet with a favourable reception.

Electricity; Its Place and Power in the Universe. By "Eureka." Glasgow: W. Hodge & Co. 1904. Price 1s. net. In this pamphlet the author sets himself (or herself) to justify the "single theory of electricity and magnetism." Incidentally, he attempts to demonstrate that gravitation is electrical. The internal heat of the earth is ascribed to the inflow of electricity. Seeing that the author confuses force with energy, saying that "energy is expressed by what we call weight," and speaks of an electrical current as "a flow of ether into the body which has been rendered vacuous," it is hardly necessary to discuss his theories seriously. His criticisms of the work of such men as Faraday on terrestrial magnetism are amusing, seeing that he believes that the magnetic needle sets itself *in* the direction of the lines of electric flow. But we must not waste further space on this egregious "Eureka," who has found merely a mare's nest.

The Fan. By C. H. Innes, M.A. Manchester: The Technical Publishing Co. 1904. The author, dissatisfied with the current theory of the fan, applies to the latter the theory of the centrifugal pump, giving as his justification for this proceeding the fact that the pressure employed is never such as to materially compress the air discharged, which may therefore be treated as if it were an incompressible fluid. Attention is called to the defects of the anemometer, which, as well as the Pitot tube, tends to give an exaggerated value for the quantity of air discharged. We can well believe this, having regard to the incredible claims which have at times been put forward for the delivery of fans. The author, after discussing the theory of centrifugal or radial-flow fans, goes on to deal with the design of these, followed by that of mixed-flow fans, and gives a very large number of experimental results, accompanied by drawings, which occupy, with descriptions of various makes of fan, five chapters. It is then shown that the results obtained agree remarkably well with the calculations based upon the author's theory. A chapter follows on high-pressure fans, after which the theory and design of propeller or ventilating (axial-flow) fans are dealt with. In this case also much space is devoted to experimental results. The treatment of the whole subject is very comprehensive and detailed, and the work must prove of great value to designers and users of fans.

Modern Iron Foundry Practice. Part II. By G. R. Bale. Manchester: Technical Publishing Co., 1905. Price 3s. 6d net.

Part I. of this work was noticed in the ELECTRICAL REVIEW in October, 1902. The present section deals with machine moulding, cleaning castings, shrinkage and distortion, tests of cast-iron and foundry accounts. The author is well acquainted with his subject, and describes a large number of machines used for various purposes, giving also full details of the mode of handling them. After describing sand-blast apparatus for cleaning castings, the author discusses the causes of bad castings, and points out features to be avoided and precautions to be taken to prevent their occurrence. Dealing with tests, the author shows the effect of chemical constitution on physical properties and gives details of the recognised methods of testing cast-iron. The book will be of value to those who are in charge of iron foundries, or of work in connection with cast-iron.

Practical Mathematics. By A. Consterdine and A. Barnes. London: John Murray. 1905. Price 2s. 6d. This is a work for beginners and elementary students, and is designed to inculcate into them a working knowledge of the subject in connection with actual measurements (made by them). Geometry, as well as arithmetic and algebra, is dealt with, and abundant practical examples are provided. Rules not in general use are excluded. There can be no question as to the thoroughly practical nature of the instruction; accuracy of measurement is taught, rough sketches are freely used, and the use of approximations is explained, in the first chapter. Even the truth of the straight-edge is checked. The value of π is determined by measurement. Further on, squares, levels and plumb rules are requisitioned, and squared paper. The student has to sketch his desk, and calculate the area of its surface. Graphical exercises follow closely upon simultaneous equations, and the latter are solved by means of the former. Ideas of volume are acquired by the aid of cubes, with which rectangular prisms are built up, and the connection between weight and volume is shown by means of the balance. Finally, experiments with the pendulum are introduced, and the ideas of time, speed, &c., are explained. The book is one which would horrify the old-fashioned type of mathematician, but will receive the cordial approval of the physicist; the student who finds his work tedious and distasteful under its guidance may safely be set down as mentally defective. We do not say that the book is faultless, but it is certainly one of the best of its kind that we have ever seen.

"Sir Henry Bessemer, F.R.S." An autobiography. London: *Engineering.* 16s. net.

Trade in South Africa.—It is stated in the current issue of the *British and South African Export Gazette* that the total volume of goods imported into South Africa last year amounted to £35,456,518, a sum which, although less than that for either the boom years 1902 or 1903, was, nevertheless, £3,861,889 more than for any previous year. Towards this amount the United Kingdom contributed £22,073,791, or 62·4 per cent. of the total, being a slight increase of 0·9 per cent. on 1903. The share of British Possessions was £4,919,014, or 13·9 per cent., an increase of 3·7 per cent.; that of non-competing foreign countries, £2,759,503, or 7·6 per cent., a decline of 1·7 per cent.; and that of competing foreign countries, £5,704,210, or 16·1 per cent., a decline of 3·9 per cent. The volume of trade done by the principal competing foreign countries was:—United States, £3,445,539; Germany, £1,251,298; Belgium, £538,116; Holland, £283,083; and France, £148,905. Our contemporary deals with the progress of British, colonial and foreign trade with South Africa over a period of 10 years, and shows that, although British trade has increased in volume from £12,901,434 in 1895 to £22,073,791 in 1904, yet these figures represent a proportionate decline in the share of the United Kingdom of from 75·9 to 62·4 per cent.; while in the case of competing foreign countries there has been a rise of from 13·7 to 16·1 per cent. Our contemporary says that an early revival in trade in the South African markets appears to be imminent.

Widnes-Runcorn Transporter Bridge.—We are informed that the suspension cables used in connection with this bridge were supplied by the ST. HELENS CABLE CO., LTD., of Warrington. It is claimed that they are the largest cables ever made for this class of work.

Delagoa Bay.—The secretary of the Lourenço Marques Chamber of Commerce at a recent meeting of that body read a letter from the UNITED ENGINEERING CO., of Johannesburg, in which complaint was made of the "violent and inconsiderate" treatment their higher class electrical goods received at Delagoa Bay. It was stated that so great had been their losses through breakage that they had experienced difficulty in insuring. The matter is to be brought to the notice of the District Governor.

Catalogues and Lists.—Messrs. Reavell & Co., Ltd., Ipswich. New catalogue C10, showing the latest designs of their air-compressors for electrical driving. The special feature in these machines is that they are arranged for being directly coupled to electric motors without the intervention of any gears, and yet maintaining only two bearings in the compressor and motor complete. The construction is shown in section for double-ended machines with a polyphase motor, one of which (of 80 B.H.P) is to be seen at the firm's exhibit at Liège. There is no need to provide a fly-wheel with this type of compressor, because the torque is almost perfectly regular. The list illustrates the smaller duplex compressors which Messrs. Reavell have made in large numbers for central stations and sub-stations for cleaning purposes, and which they will be exhibiting at the approaching Tramways Exhibition. The latest design of their two-stage compressor is also illustrated, and these machines are in use in central stations in London and elsewhere for supplying compressed air at high-pressure for air-lift purposes.

Messrs. David Rowell & Co., Westminster, S.W. Illustrated price list of iron fencing, gates and buildings, constructional steel work and iron bridges.

Messrs. Barnard Grant & Co., 27, Mincing Lane, E.C. Price list of electric lighting wires and cables manufactured by the Land and Sea Cable Works, Ltd., of Cologne-Nippes.

Atlas Carbon and Battery Co., Ltd., Southwark. A number of loose lists of "Atlas" porous pots, new central zinc batteries, "Dania" dry cells, carbon brushes, &c.

Messrs. Arthur L. Gibson & Co., 19-21, Tower Street, W.C. Catalogue illustrating and describing the "Kinnear" patent steel rolling shutter which is in use at a number of electric tram-car sheds in this country, including those at Nottingham, Manchester, Bexley, Glossop, Bournemouth, L.C.C. (Clapham depôt), and Cardiff, and many others; also at Lot's Road generating station, various railway warehouses, repair shops, &c. Sectional drawings are used to explain the constructional principles of these shutters and the different arrangements and methods of attachment adopted to suit actual conditions. The "B and S" folding gates and other specialities are also shown.

Weston Electrical Instrument Co., Audrey House, Ely Place, E.C. An excellent catalogue of the well-known Weston electrical measuring instruments. It is divided into four sections: (1) portable and laboratory instruments for direct current; (2) portable instruments for alternating and direct currents; (3) switchboard instruments for direct currents; (4) diagram of dimensions and condensed price list of switchboard instruments. A notice regarding the company's London office appeared in our last issue.

Messrs. Mavor & Coulson, Ltd., Glasgow. Date card for month of June, giving on the back data relating to the performance of a Pick-quick Longwall coal-cutting machine at a Lanarkshire colliery. The firm is issuing a series of monthly cards, each bearing fresh data relating to working results.

Westminster Electrical Testing Laboratory, York Street, S.W. Leaflet relating to incandescent lamps as light standards, in which they announce that they have arranged with the Zurich Incandescence Lamp Co., Ltd., of Kew, to supply them with lamps specially designed for use as standards. These lamps are aged and tested at the Westminster laboratory, and descriptive and price particulars appear in the leaflet.

Trade Announcement.—Mr. G. R. Sanderson has opened offices at 28, Station Road, Workington, for trading in electrical and mechanical supplies generally. He invites firms to send lists and prices and discounts.

Dick, Kerr Contracts.—The following contracts have recently been booked by Messrs. Dick, Kerr & Co., Ltd.:—

L.C.C.—8 miles of permanent way (conduit system); five motor-generators, each of 500 kw. capacity.
Heywood.—Two 200-kw. D.C. sets.
Birmingham.—11¼ miles of permanent way; 200 cars and equipments.
Metropolitan Electric Supply Co.—Two 500-kw. motor-generators.
Batley Corporation.—5½ miles permanent way and overhead equipment.
Johannesburg Municipality.—100 single-truck top-covered cars and equipments; two watering cars.
Burnley Corporation.—One 500-kw. D.C. generator.
Ashton-under-Lyne Corporation.—Six cars and equipments.
Exeter Corporation.—Two cars and equipments.

Temporary Electric Wiring in Steel Tubes.—Messrs. Simmonds Bros., Ltd., have sent us particulars of their method of temporary wiring in steel tubes specially designed for the prevention of fire risks and of electric shock. The system consists of 60/30 S.W.G. cables, 1,000 megohm insulation, enclosed in fireproof and waterproof flexible steel tubing, with mechanical couplings at intervals for connecting in lengths as required, and for attaching electroliers and fittings at any desired position. The whole is plated Venetian bronze, which gives it a handsome appearance calculated to harmonise with any decorations. The ease and facility with which the system is erected specially fit it for fixing in houses and buildings that are unwired, or for additional temporary lighting without interference to existing installations. The tubing being only ½ in. in diameter can be laid along picture rails, cornices, &c., without being seen, no fixing being required, and the walls, &c., are not in any way damaged. The wiring, when fixed, forms a continuously covered metallic system. One size of cable only being used, *i.e.*, 60/30 (carrying 7·2 amperes at 1,000 amperes per sq. in.), divided into 5-ampere circuits, leaves no chance of mistake by overloading through using the wrong size of cable, and keeps down the voltage drop on long runs. No connecting-up in the usual way is necessary, all fittings having a plug to attach to the couplings. The electric coupling is so designed, that a perfectly tight electric connection is ensured always, which cannot wear loose, has no exposed parts, and is very neat and compact in appearance. Messrs. Simmonds Bros., who make up this kind of wiring, may be addressed at 4, 6 & 8, Newton Street, High Holborn.

Factory Returns.—At St. Helens Police Court, on Friday last, The St. Helens Cable Co., Ltd., were summoned for not furnishing a return of the number of persons employed by them, as required by the Home Office regulations. Mr. Graves, Government Inspector, stated that the form which should have been returned to the Secretary of State, giving the number of employés, had not been so returned. The number of employés was about 200. The Legislature looked upon the factory returns as of considerable importance, as they took the form of an industrial census, and unless the returns were sent in the census was inaccurate and really of no value. For the defence, it was stated that the omission was really an oversight, and as soon as it had been brought to the company's notice they had filled in the form and returned it. They gave an assurance that it would not happen again. Mr. Graves stated that there were many cases outstanding, and he had been instructed to take action in a number of them as a warning to others. A fine of £1 and 4s. 6d. costs was imposed.

Strike.—According to a Glasgow paper, a strike is in progress affecting a number of the brass-finishers and iron-turners employed at the works of Messrs. Lowdon Bros. & Co., electrical engineers, Dundee. The dispute has reference to the allocation of work, the brass-finishers objecting to certain jobs which they consider to be within their province being performed by the iron-turners. The employers affirm their determination to have no further relations with the strikers, so that the quarrel has resulted in what is virtually a lock-out.

Ferranti, Ltd., and Witting, Eborall & Co.—We are informed that a working arrangement has just been entered into between Messrs. Ferranti, Ltd., and Messrs. Witting, Eborall and Co., Ltd., which is of considerable interest to the electrical industry, as it affords an instance of the combination of two competitors who at one time held widely divergent views in respect to various matters connected with the design of high-pressure switchgear and the like. In the future Messrs. Ferranti's interests in India, South Africa, and (largely) on the Continent, will be looked after exclusively by Messrs. Witting, Eborall & Co., who have in addition come to an understanding with Messrs. Ferranti in respect to work in Great Britain. Thus, for instance, it will now be possible to obtain Ferranti material through any of Witting, Eborall & Co.'s branch offices or agencies under precisely similar terms as if ordered at Hollinwood. Further, each firm will have the benefit of the other's experience, and as both firms have made a speciality of high-pressure switchgear and the like, the combination, in this respect particularly, should prove a strong one.

Liquidation.—Steam Power Syndicate, Limited. Creditors must send particulars of debts, &c., to Mr. H. W. Wilkinson, 2, Queen Anne's Gate, S.W., the liquidator, by July 21st.

Bankruptcy Proceedings.—A. G. Inrig, electrical engineer, Tottenham and Woking.—First meeting, June 19th, at 24, Railway Approach, S.E.; public examination, July 4th, at Town Hall, Guildford.

Holmes & McCallum (A. Holmes and A. McCallum), electrical engineers, Crown Works, Darwen.—Order made June 6th.

Albert Smith (Electric Motor Supply Co., Nottingham).—June 24th is the last day for receiving proofs for intended dividend. E. W. Humphreys, 4, Castle Place, Park Street, Nottingham, receiver.

Fred Shaw, electrical contractor, Hessle Road, Hull. First meeting June 21st; public examination, June 26th, both at Hull.

For Sale.—The War Office is inviting offers for surplus boilers, dynamos, &c., at Bermuda, Woolwich and other places. See our advertisement pages.

LIGHTING AND POWER NOTES.

Alloa.—The British Electric Plant Co. has offered to accept £10,000 to terminate its agreement with the T.C., but, on the recommendation of its committee, the Council will not entertain this, and has resolved that the street arc lamps be cut off, it being anticipated that a saving of £168 will be effected by the substitution of incandescent lamps.

Belfast.—The Corporation has resolved to reduce the price of energy for power and heating purposes as from July 1st next. Special prices are to be offered to consumers using energy during certain hours and for stand-by purposes.

Bath.—There was no opposition at the L.G.B. inquiry on June 6th into the application of the T.C. for a loan of £19,000 for E.L. purposes. Of this sum £9,000 represented excess expenditure, and the Inspector (Mr. H. Ross Hooper) intimated that much of the excess might have been avoided had the original estimates been more carefully prepared.

Bishop Auckland.—The County of Durham Electrical Power Distribution Co. announces that it intends to transfer its powers under the Bishop Auckland E.L. Order to the Cleveland and Durham County Electric Power Co., the money consideration being £2,083, and also the Auckland Rural E.L. Order to the same syndicate for £1,117.

Bangor.—An explosion recently occurred at the electric lighting works, which is stated to be due to an accumulation of water in the steam piping.

Barrow.—The returns of the past year's working of the E.L. department show that the total capital outlay on the works is £92,555. The revenue has gone up from £9,248 to £11,623, an increase of £2,375 during the year; the expenditure, however, was only £350 greater. The gross profit amounted to £6,698, and after deducting financial charges amounting to £5,499, the net result was a profit of £1,199. The number of units sold increased from 540,146 to 837,454.

Brentford.—The electric lighting of the district has been settled by the B. of T., who, after considering the representations made on behalf of the D.C. and the two companies, who applied for prov. orders, decided to dispense with the consent of the Council in regard to the application of the Brentford Electric Supply Co., and to grant it the order. The application of the Metropolitan Electric Supply Co. was refused.

Bristol.—The Corporation has resolved to reduce the price of energy for lighting from 5d. to 4½d. per unit as from October 1st next. The same discounts as hitherto are to be allowed.

Brynmawr.—Messrs. Copland & Cardin, of Newport (Mon.), have reported to the U.D.C. that an electrical plant to light the whole of the district could be provided at a cost of about £8,000. The Council has asked the firm to advise as to the probable working cost and revenue.

Buckingham.—The T.C. has accepted the tender of the local E.L. Co. for public lighting.

Burton-on-Trent.—Sanction has been received from the L.G.B. for loans amounting to £5,611 to defray excess expenditure on works for which loans have been previously sanctioned, £4,000 for the extension of mains, &c., and £500 for the provision of a 100-kw. D.C. tramway generator, regarding which an inquiry was recently held by the B. of T.

Castleford.—The U.D.C., on June 8th, resolved to engage Messrs. Medhurst, Page & Co. to prepare a full report *re* the proposed combined E.L. station and refuse destructor, at a fee of 40 guineas.

Chatham.—In connection with the disastrous fire at the Chatham Electricity Works, a formal agreement with Gillingham Borough Electricity Department has been signed, whereby the latter is to supply the Kent Electric Power Co. with electrical energy for its users, for a minimum period of six months at 2½d. per unit; a new boiler is to be purchased and fixed at the generating station, capable of evaporating 5,000 lb. of water per hour, its estimated cost being £1,000. Messrs. Henley's Telegraph Works Co. have been entrusted with the work of laying the cable from Gillingham to Chatham. The power company is taking advantage of the trenches which are being opened by the National Telephone Co. in Rochester, for the laying of mains from their Chatham Station to the Frindsbury Power Station. The solicitor of the company informs us that the destroyed works were ensured for £21,300 in five offices.

Continental Notes.—Germany.—The municipal authorities of Oldenburg have decided on the establishment of an electricity works in the town.

Italy.—A concession has been applied for to put down a water-power plant on the River Lys (Turin province) for generating electrical energy for power purposes.

Spain.—An electrical power concession has been granted to put down a plant to utilise the water power of the River Tajo at Puebla de Montalban (Toledo).

Coventry.—The E.L. Committee has recommended the T.C. to undertake to maintain and replace consumers' lamps, subject to a graduated scale of quarterly charges.

Croydon.—The C.C. has decided to illuminate the Croydon Borough Hospital with electricity.

The E.L. Committee is preparing a report on the comparative cost of street lighting by electricity and gas.

Dewsbury.—The tenth annual report of the electricity undertaking shows that during the year ended March 31st last, the receipts amounted to £9,303, as compared with £8,814 in the previous year. Working expenses totalled £4,859, as against £4,160 in 1903-4. The gross profit was £4,394, as compared with £4,653. Interest absorbed £1,330, and sinking fund £1,812, leaving a net profit of £1,243, against £1,951 in the previous year. The reduction of £708 in revenue is partly accounted for by the reduced prices from October; £1,000 was granted in relief of the rates, and £250 transferred to the reserve fund, which now stands at £799. During the year 989,037 units were generated, and 877,649 units were sold as under:—Public lamps, 25,272 units; traction, 517,318 units; and private consumers, 335,059 units. In the previous year, 437,432 units were disposed of. The average price obtained for lighting was 4·35d. per unit, for motors 1·93d., and for traction 1·48d., the net average price for all purposes being 2·44d. per unit. The cost of working shows an improvement over the previous year. The total length of feeder cables laid is over four miles, and there are 17 miles of distributing cables laid in 5¾ miles of streets.

Glasgow.—In view of the satisfactory results of the past year's working, the Electricity Committee of the Corporation expects to reduce the initial charge per unit for two hours' use maximum demand from 6d. to 3½d., and also the charge for stair lights from 25s. per lamp per annum to 15s. per lamp per annum.

Gorton.—The U.D.C. has decided to adopt electricity for the public lighting of the principal streets, energy being supplied by the Manchester Corporation. There will be provided 41 arcs, representing 16,400 c.p., at an annual cost of £328. The existing gas lamps represent 3,500 c.p. and cost £246 a year.

Govan.—The extension of the electric lighting works has just been inaugurated. The scheme involved an expenditure of £35,364, and includes a new switchboard, two batteries, two balancers, nine duplicate feeders, and four mid-wire feeders. Surface condensers have been installed, one condenser serving four engines, and one each for the other two. Two new boilers have been erected, with an evaporative capacity of 16,000 lb. of steam per hour at 160 lb. pressure. As the works are far from any water supply, a cooling tower and pond have been constructed for the condensers. During six years since the opening of the station, the capital expenditure has increased from £16,000 to £94,000.

Grays.—The U.D.C. has received from the L.G.B. sanction for a loan of £6,000 for the extension of the E.L. works.

Halifax.—The Corporation has decided to apply to the B. of T. for its approval of the change by the Corporation of the method of supplying electricity from alternating to a direct-current three-wire system at 230 and 460 volts on the three-wire system.

Hindhead.—In 1900, Mr. J. Grover (the present managing-director of the Hindhead and District Electric Light Co., whose meeting is reported in our "City Notes" to-day) who is largely interested in the development of the Hindhead Estate, decided to put down a small electric lighting plant for the purpose of supplying energy to the Moorlands Hotel and one or two surrounding houses, and retained Messrs. Handcock & Dykes to prepare the plans. The original plant consisted of two 15 ft. × 5 ft. Cornish boilers, each to evaporate 1,400 lb. of water per hour, working at 150 lb. per square inch, and an improved Berryman feed water heater; two Reavell vertical high speed, compound, non-condensing steam engines, each direct coupled to a Lancashire Dynamo Co.'s dynamo, to give 35 amperes 450 volts, at 450 r.p.m., but capable of running up to 550 volts when charging the batteries; the latter consisted of 240 cells capable of discharging up to 60 amperes and of giving 40 amperes for four hours at a terminal voltage of not less than 440. The mains originally laid were ·25 sq. in. and ·15 sq. in. three-core, paper, lead-covered, British insulated wire cable, laid in wooden troughs. In the course of time applications were received from additional houses, and finally it was resolved to apply for an electric lighting provisional order, which was duly granted in 1902. In 1904 an extension of the plant became necessary, and owing to the high cost of coal and the cost of carting it several miles from Haselmere station, it was resolved to put in a Diesel oil engine coupled to a Siemens dynamo. This engine of 40 B.H.P. was put to work last autumn, and has proved most satisfactory. To meet the further demands an additional set has been ordered this spring, in the shape of another Diesel engine of 80 B.H.P. coupled to an Electric Construction Co.'s dynamo. The new set is to be ready for running by the autumn. In addition there has been installed a pair of balancers, each capable of giving 20 amperes at 220 to 230 volts, and a Siemens booster set consisting of a motor and two generators capable of giving 30 amperes, 10 to 50 volts on each side of the three-wire system. The total route length of mains now laid is approximately six miles, the farthest light being approximately 1¾ miles from the station. The latter mains were laid solid in stoneware conduits instead of wood troughing. The station buildings are interesting, as it was felt that in the locality anything in the nature of a shaft or ordinary station buildings would be out of place, and they have therefore been designed to look like an ordinary red brick private residence, a very steep pitched roof coming nearly to the top of the chimney stack. The station is run by a resident engineer, Mr. Reader, who has his house at the station.

Horsham.—A L.G.B. inquiry was held on the 6th inst. into the application of the U.D.C. for a loan of £5,123 for electric lighting purposes.

Kings Lynn.—At Wednesday's T.C. meeting it was reported that the electricity department had a net surplus of £367 on the year's working, against £486 last year.

Leyland.—The U.D.C. has applied to the B. of T. for an extension of time in which to carry out the E.L. order.

Maidenhead.—The loss to the borough on the E.L. department for the year just ended is £940. The estimated loss on the ensuing year is put at £550.

Middlesbrough.—The Corporation E.L. Committee reports that the undertaking last year yielded a profit of £504.

New Malden.—The clerk of the U.D.C. has been authorised to communicate with the various E.L. companies who had given notice of their intention to apply to Parliament for powers, and who subsequently withdrew, to ascertain upon what terms they were prepared to take over, on lease, the powers given by the Council's prov. order.

(*Continued on page* 983.)

THE ELECTRIFICATION OF THE METROPOLITAN DISTRICT RAILWAY.

(*Continued from page* 943.)

The exciting plant installed in the power station, figs. 36 and 37, consists of four Allen compound two-crank high-speed engines direct coupled to B.T.-H. 125-kw. 125-volt, compound-wound generators, having a speed of 375 revs. per min.

The engines will each develop 200 I.H.P. with steam at 165 lb. pressure, superheated to 100° F., when working with a 26-in. vacuum, the steam consumption per kw.-hour being 25·4 lb.

The dynamos are designed to take a 25 per cent. overload for two hours; the exciting voltage is 125.

Further auxiliary plant installed, consists of a 125-kw. synchronous motor-generator set, three banks of single-phase air-blast 11,000 to 220-volt transformers, each bank consisting of three 500-kw. transformers, and two small 125-volt storage batteries. The motor-generator set consists of a 220-volt three-phase synchronous motor coupled to a compound-wound D.C. generator, giving normally 125 volts; it is used for charging the storage batteries, also for operating the station arcs and travelling-crane motors, for which latter purposes the exciters also are available; it can, of course, be used inversely, driven from the exciters for supplying three-phase current to the station plant.

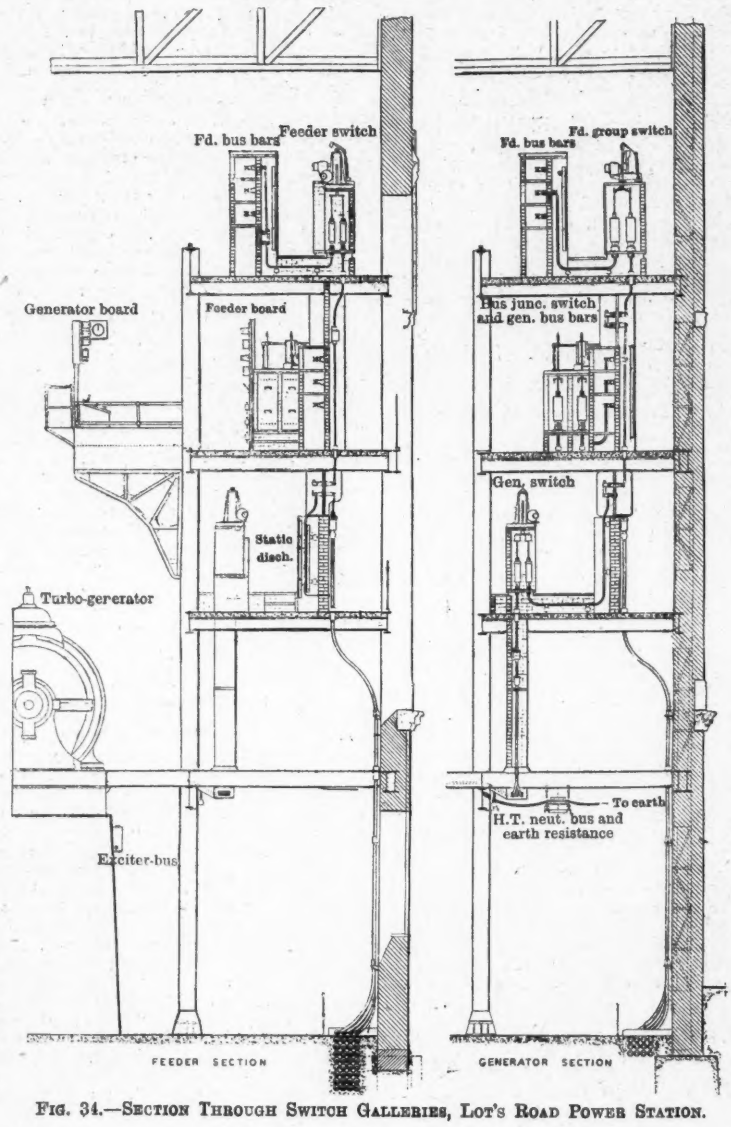


Fig. 34.—Section Through Switch Galleries, Lot's Road Power Station.

The transformers supply energy to the 80 three-phase induction motors used for operating the auxiliary plant, the only plant operated by D.C. motors being the switchgear and travelling cranes.

The storage batteries which are in duplicate for convenience in charging, &c., supply energy for working the oil-switch motors, through the control board. The engine room is spanned by two Morris & Bastert 40-ton travelling

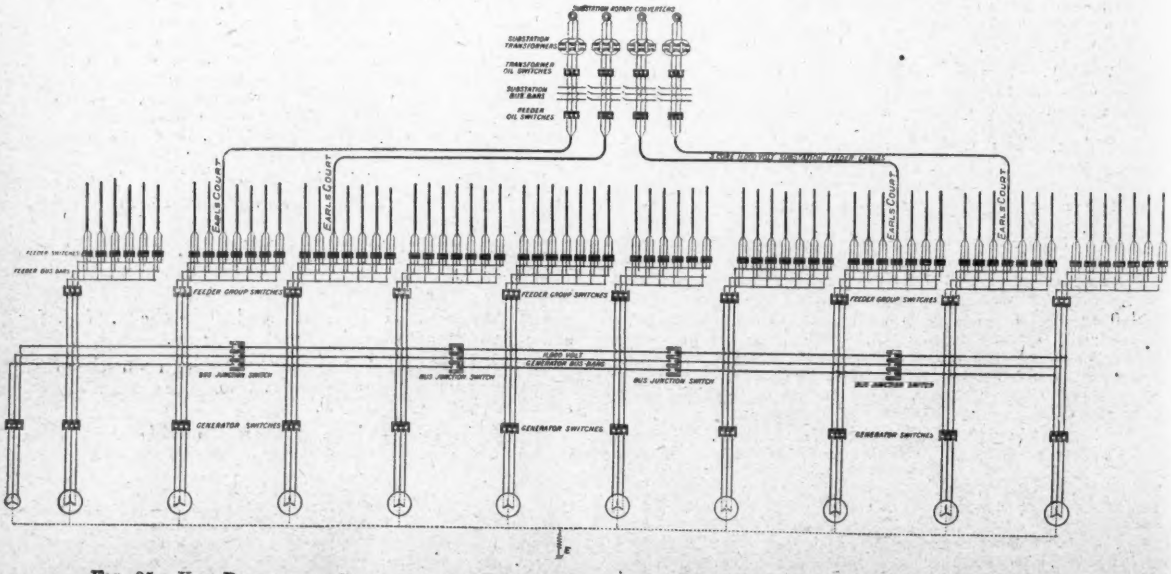


Fig. 35.—Key Diagram of Generator and Feeder Connections Between Power Station and a Sub-Station.

cranes, which are electrically operated by B.T.H. direct current motors.

In the condenser basement there are also installed two steam-driven air compressors, which are used for working the heavy valves, and for the artesian well lift; also for working the barge basin gates, capstans and wharf cranes, for opening and closing windows, and for fitting shop and cleaning purposes. A Worthington steam-driven pump is also provided for fire and drainage purposes.

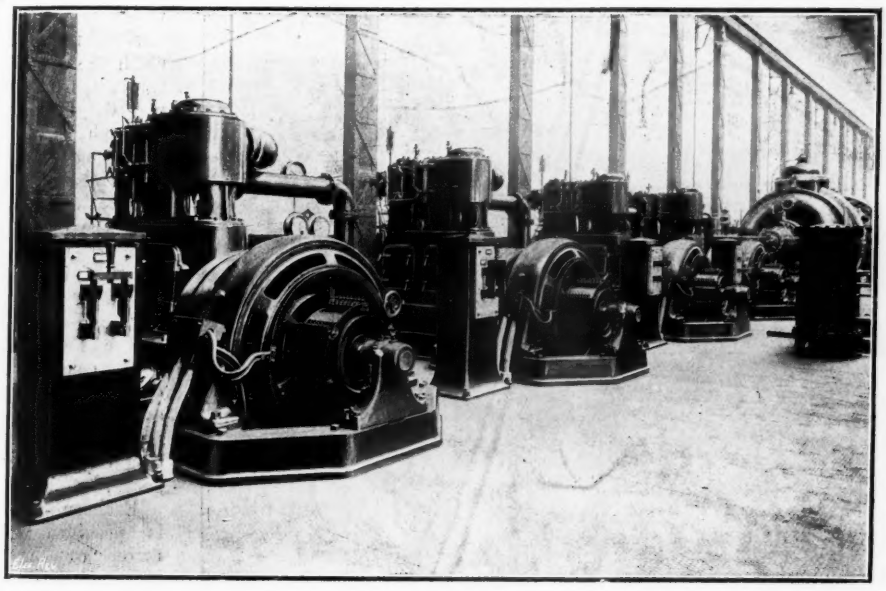


Fig. 36.—Allen-B.T.H. Exciting Plant.

Although installed in a separate building, the oil-cooling plant, which is shown in fig. 47, is an essential part of the generating plant. It has a capacity of about 20,000 gallons, the three coolers installed having each some 686 sq. ft. of cooling surface.

The oil flows by gravity from storage and filter tanks in the top of the building, through the oil-circulating system in the engine room, and back to tanks in the bottom of the building. From the latter it is forced by means of electrically-driven centrifugal pumps through the coils of the coolers up to the tanks and filters again, some 5 per cent. being filtered.

The cooling water is pumped from the river. Each cooler is provided with its oil and water-circulating pumps, arranged, as in the case of the condensing plant, with vertical spindles, the motors being on the ground floor, as shown in our illustration.

The H.T. switchgear, as previously stated, is installed on three galleries down one side of the engine room, the auxiliary switchgear being arranged on galleries at the eastern end of the engine room. It was supplied by the British Thomson-Houston Co., and all the high-tension switches are motor-operated by means of a low-pressure circuit controlled from a small pilot switchboard.

The high-tension oil switches are of the B.T.H. standard motor-operated type, as described in the Electrical

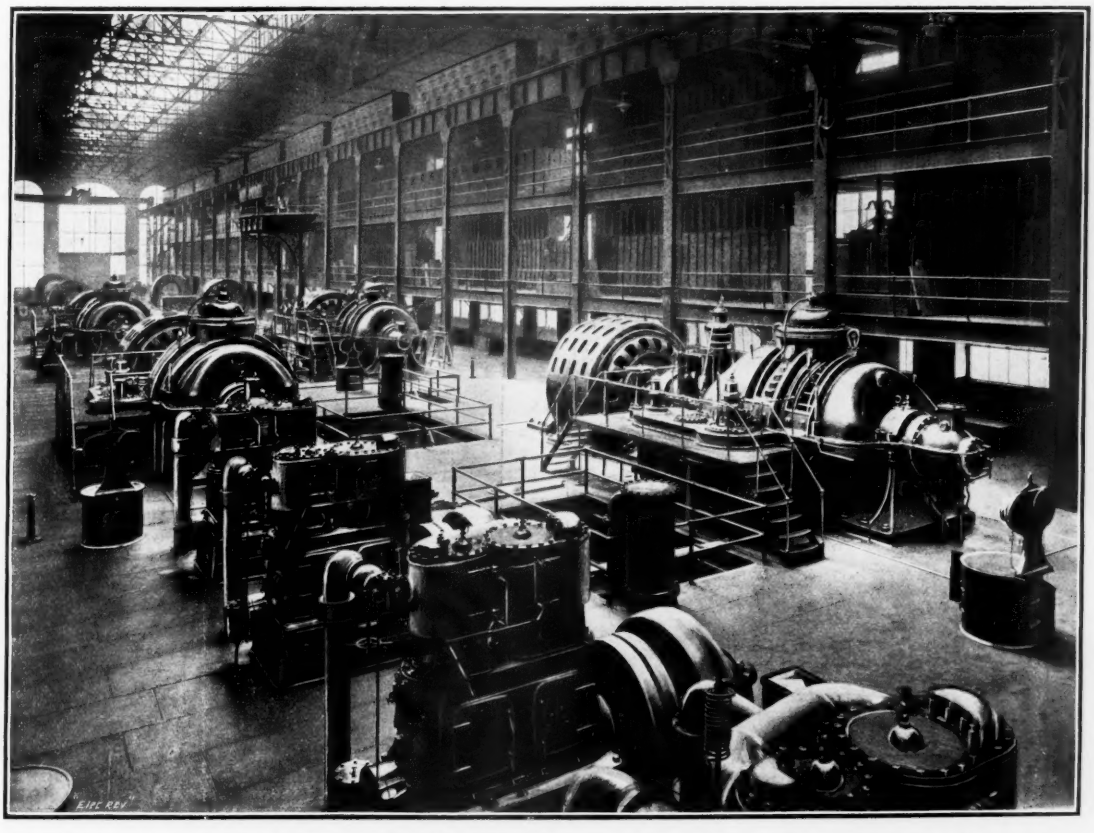


Fig. 37.—General View of Engine Room and Switch Galleries; 1125-kw. Exciter Units in Foreground, 5,500-kw. Turbo-Units Behind.

Review of September 9th, 1904; there are about 100 complete three-phase sets scattered with the corresponding bus-bars, cables, &c., over the three switchboard galleries, a general idea of which can be obtained from our illustrations, figs. 34 and 37.

The extra high-tension leads are practically direct; the several generator switches being located nearly opposite their respective generators, on the lowest switch gallery. The oil switches supplying the outgoing lines are scattered the whole length of the top gallery, and are supplied from the various sections of the main bus-bars installed on the middle gallery, which connect the several generator switches, thus there is no single bus carrying the whole station output. The extra high-tension bus-bars are not in duplicate, owing to the complications involved.

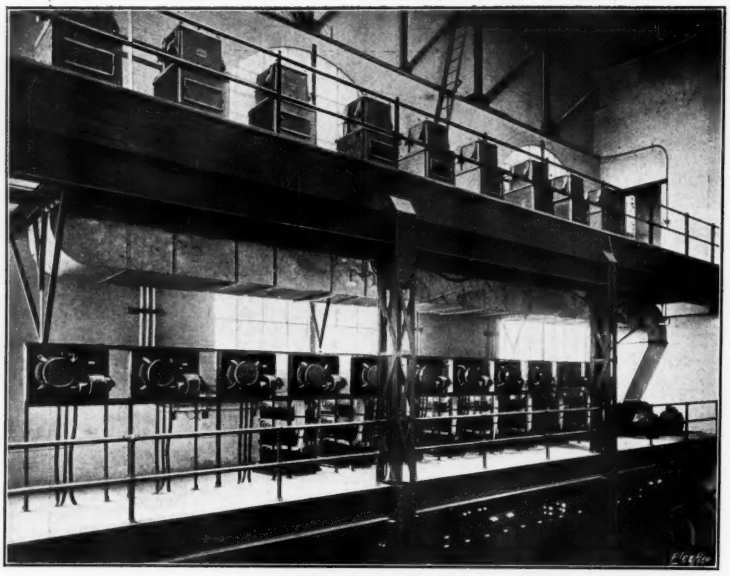


Fig. 38.—Auxiliary Transformers and Motor-Operated Rheostats for Turbo-Generators.

To give access to the extra high-tension main bus at any time without suspending service, it is divided into five sections by means of four oil switches, as indicated in the general diagram, fig. 35. To each of the five sections are connected two of the 5,500-kw. main generators, each of which is provided with one complete motor-operated three-phase oil switch. From each of the five main sections of the bus-bar, about 13 of the total number of 68 three-phase cables leading to the sub-stations, are supplied, power being delivered through two "feeder group" oil switches, each such switch feeding a short length of bus-bar, termed a "group-bus," from which in turn six or seven feeders are each supplied through a motor-operated feeder oil switch. This arrangement for grouping the feeders was adopted with the object of getting two oil switches in series with each other, so that in case of the failure of one from any cause, the other would be available to open the circuit in case of an emergency.

Each sub-station is provided with two or more separate extra high-tension three-core feeders, which supply one high-tension bus-bar in the sub-station. The several feeders to one sub-station are taken from different sections of the extra high-tension bus-bar in the generating station, so that all sub-stations can be supplied through part of their feeders, even with one complete section of the main bus-bar in the generating station out of service.

Each oil switch, as a whole, and each phase in its own cell is isolated with masonry; the idea being that if one phase should fail, the other two would open the three-phase circuit

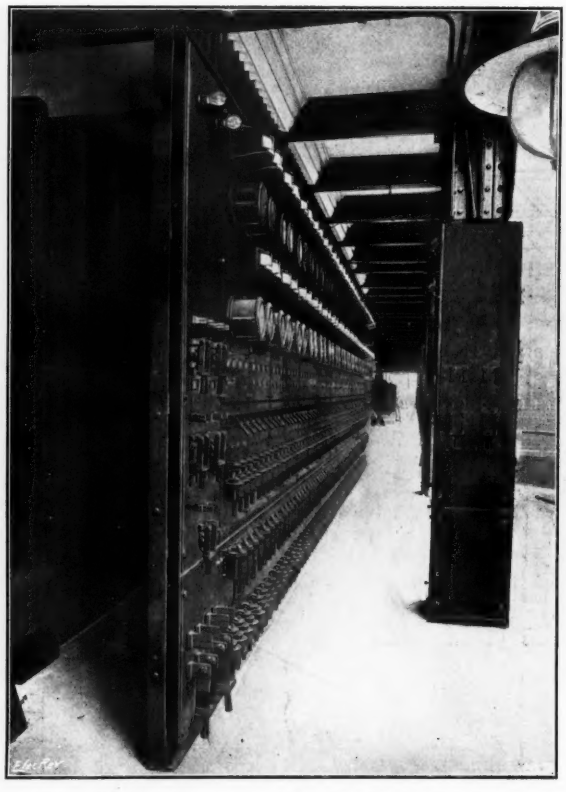


Fig. 39.—Control Board: Feeder Section.

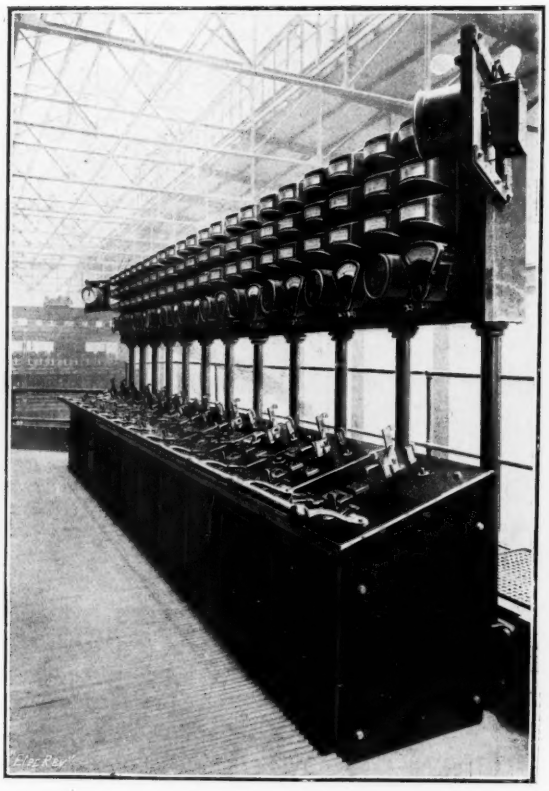
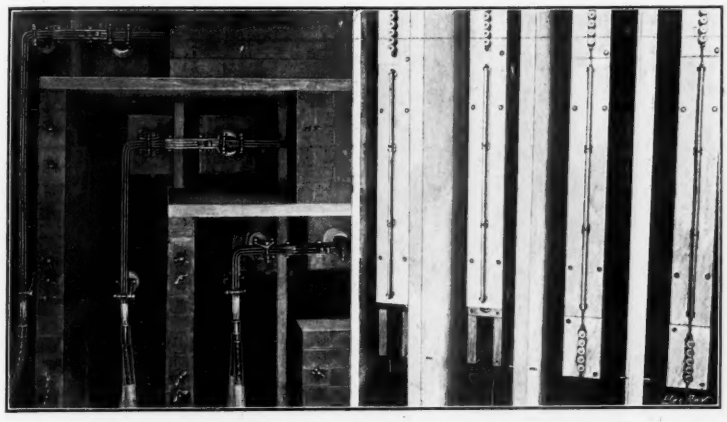


Fig. 40.—Control Board: Generator Section.

if the spread of the trouble to them was prevented. The construction of these switches is illustrated in figs. 45 and 46. The contact rods within the oil are capable of carrying about 300 amperes continuously. This is ample for any one of the outgoing feeders in this station, but in order to cope



Figs. 41 and 42.—Isolating Switches and Static Dischargers.

with the load which may come upon any one of the bus-bar section or group switches, an auxiliary contact in air is provided across the tops of the oil pots, this contact being broken before the contact within the oil pot. These air contacts can be seen in the accompanying face view of one of the bus-bar section switches. The moving parts of the switch are thrown from the "off" to the "on" position, or *vice versâ*, by means of powerful coil springs contained within the mechanism above the stone slab which forms a cover to the extra high tension parts. When thrown by one spring against the other, they are caught and prevented from rebounding by means of a clutch through which the driving motor immediately takes hold, and supplies the necessary power to complete the compression of the receiving spring.

Each oil switch is connected to the bus-bars through

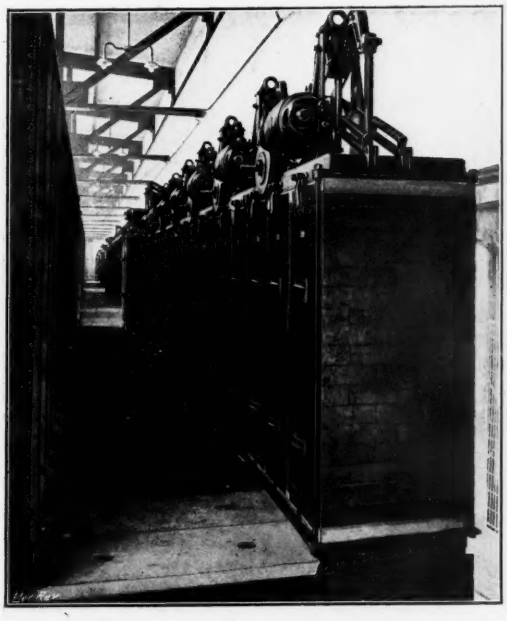


Fig. 43.—Group of H.T.-Feeder Oil Switches.

three knife-blade isolating or disconnecting switches which make it possible to test the mechanism of any oil switch without connecting the corresponding machine or feeder to the live bars. A set of these knife switches is illustrated herewith. All the high tension gear, such as main bus-bars, pilot transformers, main leads, switches, &c., is thoroughly isolated by means of masonry barriers either of brick or artificial stone construction.

The control boards for operating the H.T. machine and feeder switchgear are of two types, one consisting of the usual vertical panels, the other of an inclined bench-board or table on which are mounted the handles of the control gear, with a vertical instrument panel behind; figs. 39 and 40. The generators are controlled from the inclined bench-board and corresponding instrument panels, which stand on a projecting bay of the second gallery, while all of the outgoing feeders are handled on the vertical panels, which face the bench-board: thus when the operator faces the station, he has the control of his machines in front of him and of his feeders behind him.

On account of the size of the field rheostats necessary to handle the excitation of these large machines, their contact arms are motor-driven. A small controller on the bench-board panel for each generator, serves to start, stop or reverse the direct-current motor driving the corresponding field rhostat. Limit stops on the rheostat dial also serve to cut off the current from the motor, in case the operator attempts to run the contact arm beyond the limits of the dial. In the views of the end galleries, and also in the distance in that of the bench-board (figs. 38 and 40), the motor-operated rheostats can be seen above the auxiliary switchboard. The main

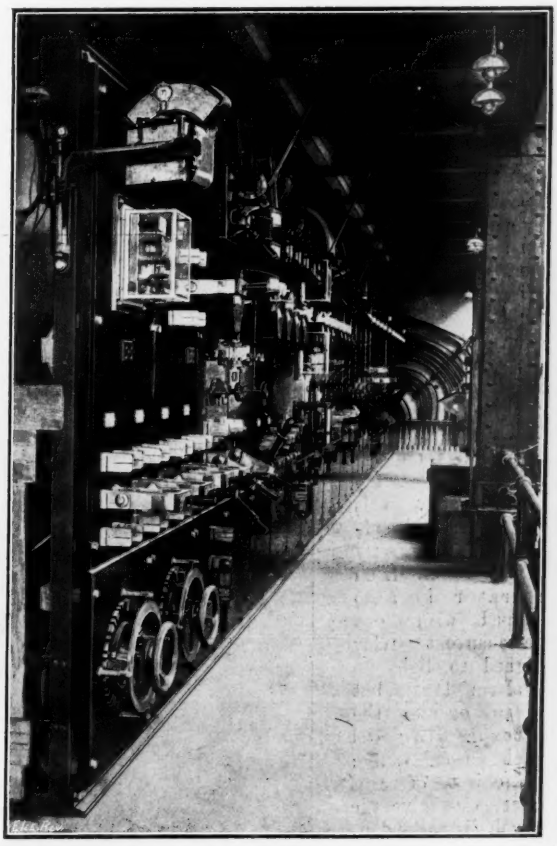
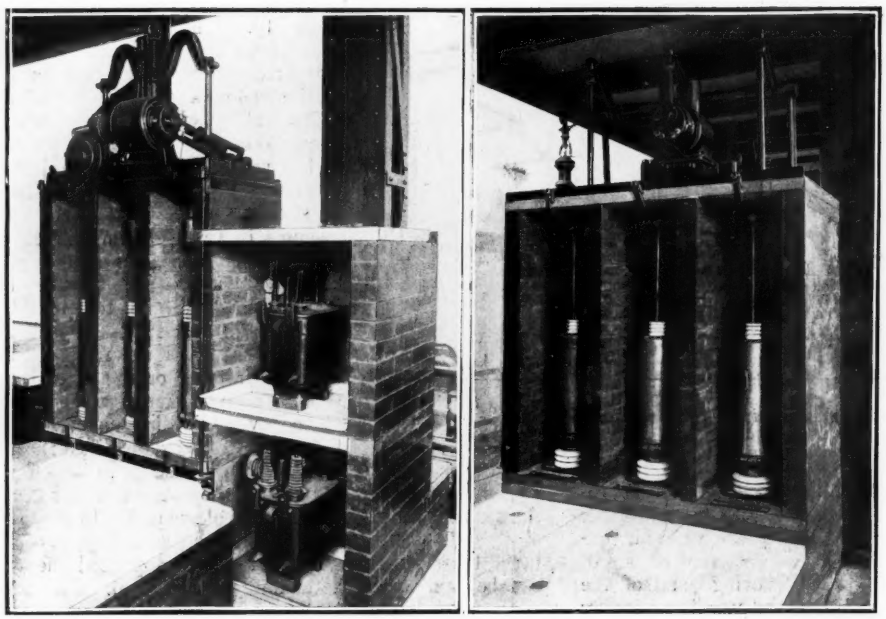


Fig. 44.—View of the Auxiliary Switchboard.

field discharge switch, which is of the single-pole type, is however, mounted directly on the generator panel in the controlling bench-board. Each generator panel is equipped with:—One controlling hand-switch for main oil-switch; two indicating lamps to show whether the main oil-switch is, in open or closed position; one field discharge switch; one

field rheostat motor-controller; one synchronising receptacle; one signal push switch, to turbine position; and one controlling switch for turbine governor motor.

By means of the last device, the speed of a turbine may be adjusted in order to bring it into synchronism with the other machines; also, when the machines are in parallel, the division of the load may be adjusted from the switchboard.



Figs. 45 and 46.—H.T. Oil Break Switches, showing Arrangement of Potential Transformers.

Each generator is also provided with the following instruments:—Three main ammeters; a main voltmeter permanently connected across one phase by means of a potential transformer; a power factor indicator; a field ammeter, and an integrating watt-hour meter.

The latter is of the single-phase type, with a potential derivation of proper phase relation to give correct readings on one phase of the three-phase circuit, this being considered sufficient with a perfectly balanced load. Each generator is also equipped with one reverse-current relay designed to light up an alarm lamp, but not to operate the corresponding oil switch automatically; the object of this device is to give the switchboard attendant instant notice on the proper panel, if any generator fails. Automatic operation of the generator switches is avoided, owing to the liability of excessive out-of-phase oscillating cross currents, due to a heavy fault on the network, pulling out the generators if equipped with reverse-current automatic release, and thus suspending the service.

The highest voltage on the switchboard or benchboard is the 125 volts of the exciter and switch-operating circuits. All alternating potentials for voltmeters, wattmeters, synchronising, &c., are derived from potential transformers having a ratio of 100 to 1, thus giving 110 volts when the line voltage is 11,000; one terminal of the secondary circuit of each of these potential transformers is earthed on a ground bus-bar which circulates through the extra high-tension gear for the purpose, so that a breakdown between the primary and secondary coils, would not raise the potential of the secondary circuits supplied from the transformer. Similarly all ammeters, overload relay coils, series coils of wattmeters, &c., are supplied from series or current transformers giving a secondary current at full load of $3\frac{1}{2}$ amperes at a pressure of, roughly 10 to 12 volts; the secondary circuits here also being similarly earthed.

The leads connecting the current and potential transformers and the oil switches with the control switchboard are run in extra heavy screwed Simplex pipe, laid on the top of the gallery floor joists, before the concrete floors were put down.

The use of extra high-tension enclosed glass-tube fuses in the primary leads of the potential transformers, prevents any considerable rush of power through them into the piping in case of a fault.

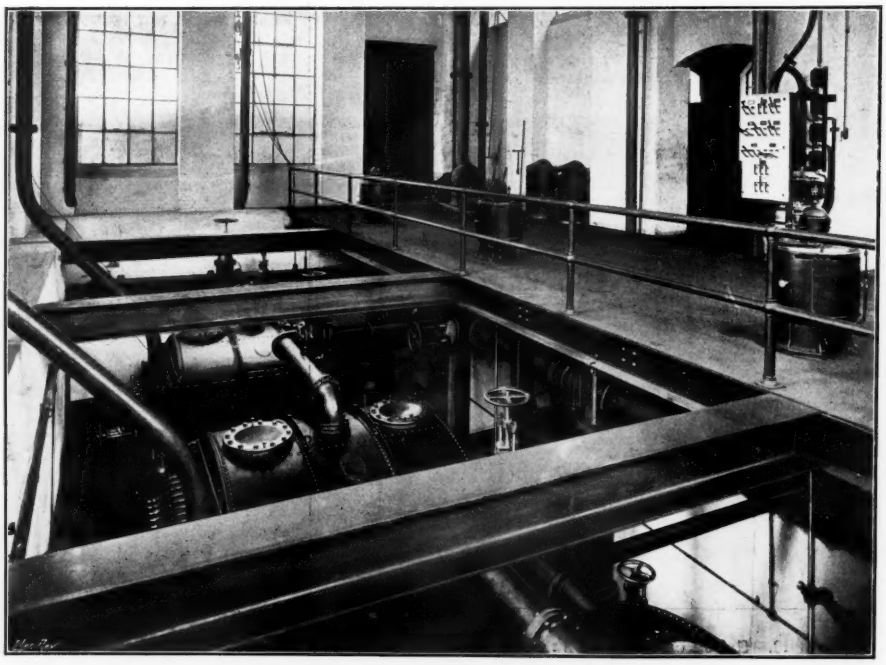


Fig. 47.—View of the Oil Cooling Plant, Lot's Road Power Station.

It will be noted that the main generator oil-switches, and the bus-bar sectionalising switches are non-automatic, the individual feeder switches being the only automatic extra

high-tension oil-switches in the station. The latter are equipped with overload relays of the adjustable time-limit type, the time feature being obtained by an air dash, designed to allow the relay contacts to close instantly in case of a short-circuit, but with a moderate overload, only to close the contacts after an adjustable time-limit of several seconds. To provide for operation with the neutral of the extra high-tension generators earthed, and to take care of all possible breakdown between any feeder conductor and the lead sheath, a relay is connected in each of the three phases of each outgoing line; the three relay contacts being connected in parallel to supply the motor of the corresponding oil switch, thus a breakdown to earth on any one of the three phases trips out the whole feeder at the generating station end. The relay contacts for all the feeders are supplied through what might be termed an alarm relay, which, in turn, rings a gong in case any extra high-tension switch trips out automatically; this alarm relay is inactive when the extra high-tension switches are opened by hand control.

To enable the operator to readily find which one of his many feeders has tripped out automatically, the alarm relay also illuminates one of 10 alarm lamps, indicating to which group the faulty feeder is connected.

The oil switchgear is designed to break any emergency current. Thus in the case of a fault upon an extra high-tension feeder, which may be rated at 2,000 KW., the power to be broken will exceed the 2,000 KW., and, in fact, be whatever the whole station can generate on short circuit, together with considerable power that will be momentarily thrown back from all synchronous machinery on the system, by virtue of its inertia and excitation.

No charging devices have been installed for the extra high-tension feeder cables supplied from this station; as with oil-break switches, the harmful effects of throwing a cable directly into circuit are to a great extent avoided. The oil-break switch apparently does not allow the current to strike across its contacts, until these are so close that the current persists without an intermittent make-and-break at each alternation.

The connection of the neutral of the generators is made through a resistance of 6 ohms, thus limiting the flow of current, in case of a dead earth on any phase, to about 1,000 amperes. This is ample to pull out the faulty feeder, but will not drop the synchronous machinery out of step, as would a dead short circuit.

The auxiliary switchgear for handling the exciters and for supplying power to the 100 or so motors for operating auxiliary plant, is mounted on an end gallery. The exciter panels are single-pole, the other polarity, together with the equaliser, being handled by switches mounted on pedestals adjacent to the exciters; thus only one polarity of the exciter system is carried to the exciter switchboard.

In connection with the duplicate storage batteries, for operating the H.T. switch motors, &c., suitable end-cell switches are provided to keep up the delivered voltage as the battery discharges, an emergency connection is also arranged so that the storage batteries may be charged from one or more of the exciters in case the synchronous motor-generator set becomes crippled. The auxiliary board also provides for supplying the direct-current crane motors from either the motor-generator set, or the exciters. Like the extra high-tension bus, the exciter bus is divided into two parts, so that continuous service can be given by the plant during repairs.

The transformers for supplying the auxiliary station circuits are located on the top gallery above this switchgear. On the extra high tension side, these transformers are supplied from three different sections of the main high-tension bus-bars through the usual group switches and individual transformer bank switches, the controlling switches of the latter being mounted on the auxiliary board. On the low-tension side, these three banks of transformers feed a 220-volt 'bus, which again is not in duplicate, but is sectioned into two parts so arranged that one bank of transformers feeds each half of the 'bus, and the third bank can be connected to either or both. These low tension connections are made by means of heavy air-break lever switches. From this 220-volt low-tension 'bus, lead-covered feeders are supplied through automatic oil switches of the hand-operated type, mounted on the back of the panels, and distribute energy throughout the whole station to individual motor-switches and starters mounted adjacent to the motors. The oil-switches in these low-tension feeder circuits are automatic and fitted with overload release, but without time-limit attachments.

At the eastern end of the building a complete suite of offices for the engineering staff is provided; this includes a fully equipped testing laboratory, where fuel, water, gas, electrical and other tests can be efficiently carried out.

In concluding our reference to the power station, we may remind our readers that it is the largest and most complete plant of its kind in the world.

(To be continued.)

LIGHTING AND POWER NOTES.

(*Concluded from page 977.*)

London.—BATTERSEA.—The B.C. has decided to petition the House of Commons against the Administrative County of London and District Electric Power Co.'s Bill, in anticipation of its becoming necessary to continue opposition; with regard to other electricity legislation of 1905, the Council will act independently of the other local authorities when Bills come before the second House. Application has been made to the L.C.C. for sanction to a loan of £8,830, to defray expenditure in connection with the extension of electricity plant and mains.

L.C.C.—The district auditor, Mr. T. Barclay Cockerton, has submitted a report on the accounts of the County Council for the year 1903-4, criticising the Council's method of rendering accounts for meter testing, which, he suggested, should be paid in advance, or collected at the time of the test.

The Council has decided to lend £9,960 to the Poplar B.C., for work at the generating station.

ISLINGTON.—The following revision of prices for energy is recommended by the Lighting Committee:—(*a*) Maximum demand system, the present charge of 7d. and 4d. to be reduced to 7d. and 3d.; (*b*) flat rate, the present charge of 5d. to be reduced to 4d.; (*c*) present charges for power, &c., to be altered from 2d., 1½d. and 1¼d., to a uniform rate of 1d.; (*d*) time limit in the case of supply for power to be abolished; (*e*) a discount of 2½ per cent. to be allowed on all quarterly accounts exceeding £5, and 5 per cent. on all quarterly accounts exceeding £10; (*f*) the foregoing charges to come into operation at the end of the September quarter.

MARYLEBONE.—The report from the borough accountant and electrical accountant, showing the result of the investigation of the books of the Metropolitan Electric Supply Co., Ltd., with reference to the consumers' accounts, shows that the total number of consumers supplied during the year was 5,801; the total number of meters in circuit was 6,482; gross income from sale of current was £133,270; the income from meter rents, £4,469; total B.T. units sold, 6,289,877; and the average price obtained per B.T. unit (including meter rents), 5·259d. The gross profits on the year's working were a little over £50,000. It is proposed to continue the company's charges to consumers to the end of the year, and then to revise them in the light of experience of the working of the system.

Motherwell.—The annual report of the Electric Lighting Committee shows that during the past year the number of units sold amounted to 730,177. The cost of production was £2,556, equal to ·82 per unit, as compared with ·88 for the previous year. The total expenditure was £2,934, and the total income £7,452, leaving a gross profit of £4,517. Financial charges amounted to £3,885, leaving a net profit of £632 on the year's working. The report was approved, and it was agreed to clear off the expenditure on free wiring account, amounting to £335, out of the profit.

Oulton Broad.—The U.D.C. has decided that in future the local E.L. Co. shall not be allowed to erect overhead wires in Cotmer Road, but must lay them underground.

Ripon.—The T.C. has decided to circularise the district to ascertain if the inhabitants are desirous of having the E.L. This decision is in consequence of a letter from the B. of T. asking if the Council intends to take any steps to carry out the E.L. Order, 1901.

Sheffield.—The returns of the E.L. Department for the year ending March 25th last, show that the total capital expended amounted to £804,527. The total revenue amounted to £59,396, and the expenditure on generation, distribution, management, &c., to £16,990, leaving a gross profit of £42,405. As the financial charges for the year amounted to £43,056, a deficit of £650 results after covering all charges. The latter amount was deducted from the accumulated surplus of £21,002. The Neepsend Works, although only in use for five months, enabled the department to generate 4,546,141 units, at a working expenditure of £16,270, as compared with 3,980,049 units and £17,234 respectively, with the old works in the previous year. The equivalent number of 8-C.P. lamps connected at March last was 340,000.

South African Notes.—Cape Town.—A Port Elizabeth contemporary states that there are now thirty-one electric cranes in position at the docks, and others are being fixed on the East Pier.

Port Elizabeth.—The local Electric Lighting and Power Private Supply Act has received the Royal assent.

East London.—On the recommendation of the E.L. Committee, the T.C. has decided to obtain an additional Davey, Paxman "Dryback" boiler for the electric power station. The electrical engineer has been instructed to proceed with the installation of electric street lighting in Acadia.

Boksburg.—The local Electric Lighting Co. has commenced operations, and a number of stores are already supplied. Owing to difficulties with the postal authorities with respect to telephones, street lighting has not yet been started.

Southwick-on-Wear.—The U.D.C. has granted the request of the County of Durham Electrical Power Distribution Co. to carry high pressure and distributing mains overhead, the company offering to supply energy at 3¾d. per unit less 5 per cent. if overhead wires are used. Sunderland R.D.C. has given similar permission to the company.

Stourport.—The U.D.C. has declined to accede to the request made by a number of ratepayers that the Council should ask the Kidderminster E.L. Co. to apply for a prov. order for electricity supply.

Swansea.—The municipal electrical undertaking shows a gross profit for last year of £7,408, and a net profit of £1,271; but as £3,125 has to be set aside for the sinking fund for previous years, in accordance with the requirements of the L.G.B., so as to bring this fund up to date, the result is a deficit of £1,109 on the undertaking.

Swindon.—The T.C. has decided to enter into agreements with any of the wiring contractors in the borough for the wiring of consumers' premises on the following terms:—For one three-light pendant, £1 0s. 6d.; for one single pendant or bracket, 12s.; for each additional single pendant or bracket within 6 ft. of the first single pendant or bracket, 8s.; lamps, 1s. 3d., 1s. 1½d. and 1s. 1d.; shades, 6d.

The L.G.B. has forwarded sanction for loans of £6,300 for cables and house connections; £1,375 for meters and demand indicators; £1,200 for motors and arc lamps; and £7,766 for new plant, buildings, &c.

The T.C. has decided to install a refuse destructor adjoining the electricity works.

Swinton and Pendlebury.—The U.D.C. has applied to the L.G.B. for sanction to a further loan of £2,000 for mains of greater capacity than those originally contemplated, owing to the unlooked-for demand for energy, and another loan of £2,617 for the extension of the E.L. supply to the Broad Oak Park district.

Tasmania.—Devonport.—Mr. G. H. Lofts, the town electrical engineer, has sent us a copy of his annual report on the E.L. undertaking to December 31st, 1904. Last year was the first complete year's working of the Town Board's scheme. The total revenue was £1,246, and the total costs, including £343 for interest and sinking fund, amounted to £1,150, leaving a net profit of £96, which is, for a colonial town such as Devonport, very creditable. The total number of equivalent 8-c.p. lamps connected was 3,097, and the number of consumers 140; 31,499 units were sold, and 5,088 units were used for street lighting. The prices charged are 8d. and 3d., maximum demand system, for lighting, and 3d. for power. The maximum load recorded was 60 kw.

The plant in operation consisted of a Climax boiler, with superheater and feed-water heater, of about 2,000 lb. water evaporative capacity per hour; one Bellis 75-h.p. compound non-condensing engine coupled to a Brush Universal 500-volt 48-kw. generator; a Tudor battery of 180 ampere-hours; a Merryweather-Brush motor pump, and Brush balancer boosters. The installation of a new B. & W. boiler, with superheater, of 3,000-4,500 lb. capacity, together with a new generating set and switchboard extension by the Brush Co., has just been carried out.

Thirsk.—The tender of the Northern Counties Electric Supply Co. for the lighting of the district for 1905-6 has been accepted by the P.C. The price is 29s. 6d. per 40-c.p. lamp per year, as against 31s. paid previously. The company's offer to make a reduction of 5 per cent., provided its tender was accepted for a period of three years, has also been accepted. The same company has secured the contract for lighting Thirsk Junction Railway station.

Tonbridge.—The U.D.C. has resolved to give a free supply of energy for electric light during June, July and August to new customers.

Wantage.—It has been intimated to the U.D.C. that the Wantage Engineering Co. intends applying for a prov. order for electricity supply.

Warrington.—The T.C. has decided to give consumers the option of a flat rate of 4½d. per unit, with a discount of ½d. per unit for prompt payment of accounts.

Whitby.—The T.C. has received permission to borrow £3,100 for the extension of plant—viz., a boiler, steam turbine, 200-kw. dynamo, and surface condensing plant.

Worthing.—The T.C. has applied to the L.G.B. for a loan of £3,300 for E.L. purposes.

TRAMWAY AND RAILWAY NOTES.

Benares.—The *United Provinces Gazette* of May 13th contains the statutory notification of an application by Messrs. Crompton & Co., Ltd., for an order authorising the construction of an electric tramway, and the supply of electricity in Benares. Single lines are to be laid between the Kashi Railway station and the courts, with crossing places where requisite. The draft of the proposed licence contains most of the usual clauses found in licences issued under the Indian Electricity Act, such as mutual powers of interference in regard to the breaking-up of roads for the laying of tramways, or the stoppage of tramway traffic for the purpose of laying sewers, drains or water pipes. The licensees have to maintain the road surface between the lines and for 12 in. on either side, and shall, if called upon by the local authority, carry—upon such conditions as not to interfere with the passenger service—all materials required by the municipality, as well as sweepings and refuse, at cost price. In case of interruption by floods the licensees may construct temporary lines. The rates to be charged to passengers are fixed at 1½ annas per mile per second-class passenger, 10 seers (20 lb.) of luggage in one package being allowed per passenger. The licensees are at liberty to charge a higher rate for first-class passengers, or for extra weight or extra packages accompanying passengers, or to carry any class of goods they may think fit, so long as the transport of these does not interfere with the safety or convenience of the passengers.

A copy of an accompanying schedule reveals that the licensees must complete a tramway at least four miles and one furlong in length within three years from the date of granting of the licence. No mention appears of a payment for track rental, and exemptions from octroi duties or municipal rates and taxes are granted to the licensees. As regards electricity supply, mains have to be laid within a compulsory area (in this case the streets along which the trams are to run) within two years of the granting of the licence. The maximum prices for energy for lighting are to be 12 annas per unit with a minimum annual charge of 20 rupees, and six annas per unit for energy for power. The prospective licensees (Messrs. Crompton & Co.) are to be allowed to make over and transfer the tramways order and electricity supply licence to a London company, provided that the municipality is satisfied as to the financial position of the proposed company.

Buenos Ayres.—A conflict has arisen between the Anglo-Argentine Tramway Co. and the Executive Government owing to the latter having granted a new concession to a syndicate, and having annulled the company's original concession over certain routes. The company has taken legal proceedings for the protection of its rights.

Croydon.—The Tramways Committee recently submitted a report recommending the Council to determine the lease of the British Electric Traction Co., which will expire on May 31st, 1906. Notice of this must be given before December 31st of this year. The Council approved the recommendation. The B.E.T. Co. wrote stating that it was about to construct the section of the tramway from Croydon to Tooting, and asking the consent of the Council to erect additional car-sheds at the Thornton Heath depôt, where the Croydon cars are sheltered. This privilege was asked for on terms, together with a request that the Corporation would also give the company facilities for running the cars from the depôt to the new lines in the event of the lease being determined. The Council unanimously decided to refuse to grant the request. It was hinted that the decision of the Council to determine the lease would allow any negotiations to go forward for the alteration of the present terms of the lease.

Derbyshire.—Recently the Mottram and Hollingworth U.D.Cs. and Tintwistle R.D.C. asked the Urban Electric Supply Co. to extend the electric tramways from Glossop into the three districts. The company, on the ground that it would not receive an adequate return for the outlay, has declined to embark upon the scheme.

Edgware.—A driver in the employ of the Metropolitan Electric Tramways, Ltd., has been committed for trial on a charge of driving an electric car recklessly in Edgware Road on Easter Monday. The car collided with a horse and van, killing the former and seriously injuring two men.

Folkestone.—The T.C. has applied to the B. of T. for an extension of time in which to commence and complete the electric tramways.

Mr. W. B. Hopkins, of the National Electric Construction Co., Ltd., attended the meeting of the Cheriton U.D.C. on June 6th, with reference to the electric tramway scheme from Folkestone through Cheriton to Hythe. Mr. Hopkins said his idea was to form "one grand municipal scheme" to connect up Cheriton and Shorncliffe with a main line from Folkestone to Hythe, which would go across Shorncliffe Camp. The Council decided that it could do nothing in the matter until it had the full scheme in detail before it.

Houghton-le-Spring.—A sad accident occurred on the newly opened line of the Sunderland and District Electric Tramways Co. last Monday. The driver lost control of a car in descending a slope near Silksworth, and it crashed into a wall. About 14 passengers were injured, and a boy was so badly hurt that he died almost immediately. Another passenger and the driver had to be removed to Sunderland Infirmary.

Glasgow.—A summary of the traffic returns of the Tramways Department for the year ending May 31st shows that during the 12 months 195,767,519 passengers were carried, against 188,962,610 in the previous year. The total traffic revenue amounted to £756,480 8s. 7d., against £717,893 4s. 2d., an increase of £38,587 4s. 5d. The car-mileage was 17,942,595, compared with 16,291,082—a difference of 1,652,513. The average traffic revenue per car-mile was 10·12d., against 10·58d. in 1903-4, while the average track mileage (single) open during the year was 144¾ miles, compared with 135 miles in the previous year.

Kirkcaldy.—Although the total number of passengers carried by the Kirkcaldy Tramways for the first year's working was 3,632,855, there is a loss shown of £1,575.

London.—City.—A conference between the Special Committee of the City Corporation, which is considering the question of tramways over Blackfriars Bridge, and a deputation from the L.C.C., took place last week at the Guildhall. The proceedings were of a friendly character, and it is expected that the Court of Common Council will rescind its resolution vetoing the proposition. The widening of Blackfriars Bridge practically amounts to the building of a special bridge for the tramways, as recently suggested by one of our correspondents, and will certainly remove many of the objections which have been raised to the laying of tramways across the river.

Newcastle-on-Tyne.—The balance-sheet of the city tramways for the past twelve months has just been issued It shows a total income of £197,850 as against £185,028 for 1903-4, an increase of £12,822. The expenditure was £127,019 as against £121,558 for 1903-4, an increase of £5,461. This leaves a net revenue of £70,831 as against £63,470 for 1903-4, an increase of £7,361. The car-mileage for last year was 4,326,152 as against 4,059,907, an increase of 266,245. The chief items of expenditure were:—Power, pumping and sub-stations and distribution expenses, £10,628; public lighting, £587; general expenses, £17,494; traffic expenses, £69,716 (which included wages, £47,940); maintenance work, £28,594. The total traffic receipts were £193,305 as compared with £180,631 for 1903-4, an increase of £12,675. As to the disposal of the profits, the interest on loans totals £33,944, while the redemption fund requires £29,718, so that a net profit on the year's working of £6,294 remains. This, with the balance from the previous year of £3,661, makes a total of £9,955, which is carried to the renewals fund. There has been paid off altogether in redemption £83,371, and £2,053 has been placed in the sinking fund. It is interesting to note that the total expenditure has been reduced to 7·05d. per car-mile as against 7·19d. for the previous year, while the revenue works out at 10·72d. per car-mile. Traffic expenditure per car-mile was 3·87d. compared with 3·97d.

New York Subway.—On Monday last a long stretch of the new subway was flooded by the bursting of a 48-in. water main, greatly disorganising the traffic.

New Zealand.—Christchurch.—Progress payments have been made by the board to the New Zealand Electrical Construction Co. to the amounts of £24,935 and £2,063 (deposit returnable).

Karori.—The ratepayers by a large majority have rejected the proposal put forward by the B.C. to borrow £29,000 for a system of Lombard motor-'buses and the installation of an E.L. plant.

Plymouth.—The T.C. has received from the B. of T. sanction to borrow £2,800 for laying the Garden Street Tramway and for electrical equipment.

South Shields.—After several years of debate, disputation and argument, and after appeals to the people for approval or condemnation of innumerable schemes, a start has at last been made with the Corporation system of electric tramways, and there is a promise of the scheme being pushed forward with all possible speed. The lease on the present tramways in the borough held by the South Shields Tramways Co. does not expire until February next, but it is intended to proceed with the construction and equipment of the new route over which the Corporation has powers to run the cars. The Stanhope Road section is to be begun first, and the line will be carried from Tyne Dock, down Stanhope Road, along Meldon Terrace and down Westoe Lane. The contract price for the permanent way is stated to be £45,000, the work having been undertaken by Messrs. William Underwood & Brothers, of Dukinfield.

Walsall.—An agreement is to be entered into with the Wolverhampton and District Electric Traction Co., Ltd., under which the Corporation shall have the right to run "through" cars over the company's lines to and from the Market place, Willenhall, on such terms and conditions as may be agreed upon by the Tramways Co. and the Corporation. For this purpose the Corporation is to extend its tramway from its present terminus in the Walsall Road, Willenhall, so as to form a junction with the tramway of the Wolverhampton and District Tramways Co.

TELEGRAPH AND TELEPHONE NOTES.

Portsmouth.—On Tuesday last week telegraphic communication with the town was interrupted for some hours, the underground telegraph wires having been flooded. Telephone trunk lines were temporarily used for telegraphic purposes.

Cable Rates.—Last week the Chancellor of the Exchequer received a deputation, introduced by Sir Edward Sassoon, urging a reduction in the cable rates to India, China and West Africa. The Chancellor deprecated the substitution of Government for private enterprise, and stated that the rate to India would, in a few months, be reduced from 2s. 6d. to 2s. a word. The rate to Egypt had already been reduced to 1s. a word.

Houghton-le-Spring.—The difficulty between the U.D.C. and the postal authorities with regard to the telegraph lines has been settled by the adoption of an entirely new route for the latter, remote from the electric tramways.

Mauritius-Réunion.—In the Parliamentary papers of Thursday last week, Sir Charles Dilke asked the Under-Secretary of State for Foreign Affairs whether his attention had been called to the announcement by the French Under-Secretary of State for Posts, that an agreement had been concluded directly between H.M. Government and France, for the laying of a cable between Mauritius and Réunion to connect with the Réunion-Madagascar cable, for which funds were voted in France more than a year ago; whether any information could be given as to the nature and details of the agreement; whether the Cables Committee recommended by Lord Balfour of Burleigh's Committee had been organised; and if so, whether the present international agreement was a first result of the work of any such committee. Earl Percy, in reply, said that negotiations had been in progress between the British and French Post Offices with regard to the laying of a cable between Mauritius and Réunion, but no definite agreement had been arrived at. The Cables Committee recommended by Lord Balfour of Burleigh's Committee was to be an extension of the Inter-Department Committee known as the Cables (Landing Rights) Committee, which had been established for some years. The question of the proposed Mauritius-Réunion cable had been under the consideration of the latter Committee.

Metropolitan District Railway.—On Tuesday last a further section of the District Railway—between South Acton and Hounslow Barracks, about 6½ miles in length—was changed over to electric traction. There will still be some delay, however, before the complete electric service on the main line can be inaugurated, mainly owing to delay in the delivery of the rolling stock.

New Atlantic Cable.—On Sunday last the cable steamer *Cambria* left Queenstown to take soundings across the Atlantic, in readiness for laying the new cable of the Commercial Cable Co. The Irish shore end has already been laid by the *Cambria* for a distance of 100 miles to sea from Waterville, Co. Kerry. The s.s. *Colonia* will leave London later for Cape Canso to lay the cable over the course charted by the *Cambria*. The latter belongs to the Telegraph Construction and Maintenance Co., London.

The Telegraph Cable Export Trade.—The fluctuating character of the export trade of this country in telegraph cables and apparatus connected therewith is clearly shown in the returns just issued for May. After a very busy time in April, when the shipments reached a total of £212,605, last month they fell to £72,853, which compares with £171,760 in May a year ago. For the five months ending with May, the shipments have attained a value of £466,793, as contrasted with £461,025 in the corresponding period of last year, and £1,362,133 in the first five months of 1903.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1)	Aug. 26, 1901	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	
Tarifa-Tangier	Jan. 18, 1904	
Closed { Vladivostok-Nagasaki	Feb. 9, 1904	
Closed { Port Arthur-Chifu	Mar. 9, 1904	
Jamaica-Colon	Jan. 5, 1905	
Bathurst-Bissao	April 22, 1905	June 11
Dakar-Conakry	May 11, 1905	
Paramaribo-Cayenne	May 25, 1905	
Landlines.		
Puerto-Barrios	July 28, 1902	
Kertch-Soutchoum	Sept. 27, 1904	
Pekin-Kiatchta	June 11, 1905	June 13
Rome-Constantinople	June 12, 1905	June 13

Wireless Telegraphy on Trains.—It appears that good results are being obtained with wireless telegraphy on moving trains between Chicago and St. Louis, U.S.A., and the railway authorities are reported to have said that they will adopt the system on the whole of the Chicago and Alton railway.

Heavy Train Loads.—The *Standard* quotes an article in a New York paper, in which it is contended that the heavy train loads which have become customary in America are detrimental to efficiency of operation. The speed at which trains, weighing 3,500 to 4,500 tons, can be hauled, even by the biggest locomotives, is only about 10 miles an hour, and the result is an actual increase in cost, besides delay both in transit and in accumulating the cars of which the long trains are composed. It is stated also that the Pennsylvania R.R. Co. is already reducing the weight of its goods trains.

CONTRACTS OPEN AND CLOSED

OPEN.

Aston Manor.—June 23rd. Electrical equipment of trolley tramways for the Corporation. See "Official Notices" June 9th.

Belgium.—June 23rd. Tenders for an installation of electric lighting in the Posts and Marine Department in the Rue Ducale, Brussels. Particulars for 1 fr. from, and tenders are to be sent to, La Direction Générale des Ponts et Chaussées, 38 Rue de Louvain, Brussels.

Darlington.—June 19th. Switchboard extension and booster for the Corporation. See "Official Notices" June 2nd.

Dartford.—June 21st. Annual supplies for electric lighting department. See "Official Notices" to-day.

Grays Thurrock.—June 17th. Storage battery, feed pump, switchboard and economiser extensions, for the U.D.C. See "Official Notices" June 2nd.

G.W. Railway.—June 28th. Pipe-work, pumps, feed-heaters, and other plant for Park Royal generating station. See "Official Notices" June 9th.

Holland.—June 24th. The authorities of the Walcheren Steam Tramway at Flushing are inviting tenders until the 24th inst. for the conversion of the Middelburg-Flushing-Dornburg line into an electric tramway.

Hornsey.—June 19th. Side-arm brackets and switch-boards for arc lighting. See "Official Notices" June 9th.

Hull.—June 22nd. One 500-KW. high-tension and one 500-KW. low-tension, continuous-current high-speed generating sets; also six Lancashire boilers with downtake superheaters. See "Official Notices" June 9th.

Italy.—June 30th. The Prefectural authorities of Messina are inviting tenders until the 30th inst. for the concession for the electric lighting of the port of Messina during a period of nine years.

Leigh.—July 1st. One water-tube boiler. See "Official Notices" June 9th.

Melbourne.—July 14th. Arc lamps, poles, brackets, &c., for street lighting for the Council. See "Official Notices" May 12th.

Metropolitan Asylums Board.—June 28th. Engineering supplies and electrical accessories. See "Official Notices" to-day.

Rotherham.—June 26th. Cable and meters for one year for the electric light department. See "Official Notices" to-day.

Spain.—July 3rd. The municipal authorities of Fregenal are inviting tenders until July 3rd for the concession for the electric lighting of the town during a period of ten years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Fregenal.

Spain.—July 5th. The municipal authorities of Mazarron are inviting tenders for the concession for the electric lighting of the town during a period of 30 years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Mazarron.

Stepney.—June 28th. Meters, demand indicators, and arc lamp carbons for electricity supply department. See "Official Notices" to-day.

CLOSED.

Ashton-under-Lyne.—The T.C. has accepted the tender of Messrs. Dick, Kerr & Co., Ltd., for six single-deck tramcars.

Canterbury.—The T.C. has appointed Mr. W. Attwaters, of Lower Bridge Street, Canterbury, to carry out electrical engineering work for the ensuing half year.

Dublin.—All the coals for the Corporation Electricity Works for next year, 12,000 tons, are being bought from Scottish collieries. Tenders close this week.

Durham Collieries.—The Durham Collieries Electric Power Supply Co. has placed an order with Messrs. Bruce Peebles and Co., Ltd., for a 9,000 H.P. generating station complete, for £92,000.

East London.—The tender of Messrs. Isaac Storey and Co., of Manchester, at £855, for a surface condenser, subject to better terms not being obtainable, has been accepted by the T.C.

Edinburgh.—The Corporation has ordered from the Stirling Boiler Co., Ltd., for McDonald Road electric light and power station, two Stirling boilers with superheaters and chain grate stokers, each boiler to evaporate 18,900 lb. of water per hour.

Faversham.—The T.C. has accepted the tender of Messrs. Callender's Cable Co. for the supply of cable, at £259.

Glasgow.—The Electricity Committee has closed the contracts for coal for the next year. In all 51,000 tons best washed singles have been bought.

Islington.—The Lighting Committee has provisionally accepted the following tenders:—

Coal bunkers and conveying gear, Messrs. Babcock & Wilcox, Ltd., £1,813 10s.; six combined feeder pillars and arc lamp columns, £22 10s. each, Messrs. Rowland Carr & Co.; seven arc lamp columns, £8 5s. each, Rowland Carr and Co.

Johannesburg.—The Corporation recently authorised the Tramways and Lighting Committee to accept the most advantageous tender for the second tramway contract. The acceptance of the tender of Messrs. Crompton & Co., Ltd., for arc lamps and that of the British Westinghouse Co. for switchboards, at £4,960, was approved.

Partick.—The Municipality has placed an order for a 600-KW. direct-coupled set, for the lighting station, with Messrs. Bruce Peebles & Co., Ltd.

Rochdale.—The Rochdale Electric Co., Ltd., has secured the contract for electric lighting machinery and wiring for the new Clover Mill which is being erected in the town.

Salford.—The T.C. on June 8th accepted the following tenders:—

Messrs. Watson Bros., Glasgow, fireproof doors (central car depôt), £271.
Messrs. Glover & Co., Ltd., paper-insulated cable (12 months).
Tudor Accumulator Co., Ltd., maintenance and repair of two storage batteries at Frederick Road Works for 10 years, £155 each per annum.
Messrs. Geo. Hill & Co., frogs, pull-offs, &c. (12 months).
Electrical Co., Ltd., London, two special meters, £29 each.
Mr. J. T. Hailwood, movable asbestos mattresses for covering economisers.

Scottish Central Electric Power Co.—Messrs. Bruce Peebles & Co., Ltd., have secured a contract for the extension of this company's generating plant. The contract includes 3,000 H.P. in steam alternators, condensers and switchboard, &c. The price is £17,000.

Swindon.—The T.C. has accepted the tender of Messrs. Veritys, Ltd., of Birmingham, for the supply of motors for hiring out, and that of Messrs. Berry, Skinner & Co., of London, for larger size motor switch fuses.

Trefriw.—(DENBIGHSHIRE). The Hart Accumulator Co., Ltd., have secured the order for a battery of 120 of their standard lighting type cells for the electricity works.

FORTHCOMING EVENTS.

To-day's Arrangements.—At 8 p.m. Physical Society. "On the Ratio between Mean Spherical and Mean Horizontal c.p. of Incandescent Lamps," by Dr. J. A. Fleming; "Electrical Conductivity of Flames," by Dr. H. A. Wilson; "Contact with Dielectrics," by Mr. R. Appleyard; "Pendulum Accelerometer, an Instrument for the Direct Measurement and Recording of Acceleration," by Mr. F. Lanchester; "Exhibition of a Refractometer," by Mr. R. Appleyard.

Tuesday, June 27th.—Annual Convention of the Municipal Electrical Association opens at Edinburgh. The meetings continue until the following Saturday:—Wednesday at Glasgow, Thursday and Friday at Edinburgh, and Saturday at Aberdeen. A detailed programme of the papers and visits appeared on p. 947 of our June 9th issue.

Thursday, June 29th.—9 to 11.30 p.m. Institution of Electrical Engineers' Conversazione at Natural History Museum, Cromwell Road, S.W.

Monday, June 26th.—Junior Institution of Engineers. "Coming-of-Age" Summer Meeting opens in London. See our "Notes" pages to-day.

Gas.—A newspaper dispatch from Cape Town says that on Tuesday morning a quarter of a mile of Adderley Street was blown up in a terrific gas explosion. "Two people are known to have been killed, and a large number injured. The tramway lines, the telephone wires, and the water and gas mains were blown out. There were several smaller explosions of escaping gas, and the water from the burst mains flooded many houses."

On 5th inst. a serious gas explosion occurred in a public-house at Saltmarket Street, Glasgow, completely wrecking the premises and causing injury to several workmen.

THE ELECTRICAL ENGINEERS R.E. (VOLS.).

The following orders are issued for next week:—

Technical Instruction at Headquarters will be discontinued until after Camps.
Wednesday, June 21st.—No Adjutant's Drill.
Thursday, June 22nd.—Recruits and Non-efficients for Falmouth and Plymouth Camp Parade at Paddington Station G.W.R., at 10.20 a.m.; those for Sheerness Camp at Victoria Station S.E. & C.R., at 12 noon.
Saturday, June 24th.—Efficients for Falmouth and Plymouth Camps Parade at Paddington Station G.W.R., at 10.20 a.m.; those for Sheerness Camp at Victoria Station S.E. & C.R., at 12 noon.

J. H. S. Phillips, Captain, R.E.
For O.C.E.E.R.E. (V.)

NOTES.

Motor-'Buses.—According to the daily Press, the motor-omnibus service of the Eastbourne T.C. was run at a loss of £1,000 during the past year, and many of the 'buses are to be converted into water vans and dust carts. "To what base uses" . . . !

Tramway Construction Difficulties at Tokio.—By the courtesy of Messrs. Dick, Kerr & Co., Ltd., we are enabled to publish the accompanying interesting illustrations, reproduced from photographs taken by one of their staff at Tokio. These views show the combined effects of rain and earthquake which were recently experienced on the tramway line which the firm now has under construction. The occurrence, as will be seen, was a serious one, for one line appears to have been completely swept away for a considerable distance, as the position of the centre pole in one of the photographs shows.

Tokio Tramway Construction Difficulties.

Visit of Mr. James Dalrymple to the United States.—According to a New York correspondent, Mr. James Dalrymple, general manager of the municipal tramway system of the City of Glasgow, arrived at New York on Saturday, May 27th, for the purpose of proceeding to Chicago to consult with Judge Dunne, the new mayor of Chicago, regarding the taking over of the Chicago traction lines by the city. Mr. Dalrymple was immediately taken in charge by representatives of the New York Municipal Ownership League, and in the evening they dined Mr. Dalrymple, and organised street processions and musical parades in his honour. At a truly democratic reception in the ball room of the Hoffman House, Mr. Dalrymple spoke of his object in coming to the United States. He said in part:—"You must not go away with the idea that I am here anything at all with regard to the principle of municipal ownership. I am simply here to tell a story to the people of Chicago. In Glasgow we have been operating a street-car service for 11 years, and during that period we have made the service exceedingly popular. Before 1894 the system was in the hands of a company, but the citizens as a whole were not satisfied with the service. They were not satisfied with the manner in which the company paid their employés, nor with the hours that their employés had to work, and a great many smaller details and the citizens of Glasgow unanimously decided to take the operation into their own hands. Now, I believe, without boasting too much, we have as good a service as there is in Great Britain. "Mr. Dalrymple proceeded to give figures relating to the cost of the Glasgow system, and averred that every penny of the capital shown on the books was represented in the present electrical equipment, and that their capital account did not represent "the cost of a horse system, a cable system, and an electrical system one on top of the other." "We run the car service," he said, "as if we were a private company, with this exception, that we have simply interest on our capital to pay, and any profit that remains goes to the benefit of the travellers. We endeavour to give the best possible service to the citizens at the lowest possible fare. I am not here to say anything about the principle of municipal ownership. It is quite possible for a municipality to make a terrible mess of a street car undertaking; it is quite possible for a company to run a splendid service; and it is quite possible also for a municipality to give a good service." Mr. Dalrymple arrived at Chicago on May 29th, and immediately began to study the situation in that city.

Appointment Vacant.—Boiler superintendent for Durban Corporation electric power station (£250 to £300).

St. Helens Tramway Strike.—We are informed that the strike, which commenced on April 27th, may now be regarded as at an end. The full services are being run, and all hostile manifestations of excitement amongst the men and the public have disappeared. The number of drivers and conductors who went on strike was 108; the number who remained loyal to the company was six drivers and three conductors, in addition to the inspectors, repair shop employés, and the clerical staff, numbering 108. During the past few days, applications for re-instatement have been received from the majority of the strikers, of whom 20 drivers and 15 conductors have been permitted to resume duty on precisely the same terms as existed before the strike. Owing to the misconduct and acts of violence known to have been committed by the remainder of the men during the strike, the company has refused their applications to be permitted to resume work, and has filled up their places with new men. The men who have been reinstated in their old positions have surrendered unconditionally, and have thrown up their connection with the Union.

Electric Power for Refrigeration.—Now that the hot weather and long days are upon us, central station engineers should not lose an opportunity of pushing the advantages of electric motor driving for fans, refrigerators, and similar purposes, so as to gain in motor load what they lose in lighting. In view of the very stringent Home Office regulations now in force as to the doctoring of milk, refrigeration is about the only satisfactory means of keeping milk fresh during the hot weather. A very convenient size of refrigerating plant for dairy work, capable, say, of chilling 150 to 200 gallons of milk in an hour and for cooling a cold storage room about 12 ft. square by 7 ft. high, takes from 3 to 3½ H.P., including the necessary shafting. The same motor can, of course, be used for driving the revolving brushes for cleaning churns, also for driving the cream separators and other dairy appliances. There ought to be a large field for motor work in this direction.

There is an interesting illustrated article in the *Electrical World and Engineer*, N.Y., for April 1st, showing some electrically-driven refrigerating plants, and giving certain data in connection therewith.

Institution Notes.—The Junior Institution of Engineers.—The "Coming of Age" summer meeting is to be held in London from June 26th to 30th. A full programme of visits has been arranged to, among other places, the Mansion House, St. Paul's Cathedral, the Royal Arsenal, the Royal Mint, Messrs. Yarrow's works at Poplar, the N.L. Railway works at Bow, the L.C.C. generating station at Greenwich, Doulton & Co.'s pottery works, Neasden power station and Earl's Court Exhibition. The conversazione takes place on Tuesday evening, June 27th, at the Royal United Service Institution; on June 29th there will be a trip to Chatham by the *Clacton Belle*, and the Institution dinner is to take place at Earl's Court Exhibition on June 30th. At the last event there should be a record gathering, as the programme tersely says, "no speeches."

Incorporated Association of Municipal and County Engineers.—The annual meeting of the Western District of this Association was held at Gloucester recently. A visit was paid to the municipal tram depôts and electricity works. A paper on "Gloucester Electricity Works," by Mr. Walker Bache (city electrical engineer), was discussed.

Boiler Explosions.—The report on the working of the Boiler Explosions Acts, during the year ended June 30th, 1904, has been issued. The *Times* says that 42 preliminary inquiries and 18 formal investigations were held during the 12 months. In 13 out of 18 cases in which formal investigations were held, blame was attached to the owner of the boiler or to his employé, and in two cases the persons who advised the owner as regards the efficiency of the boiler were blamed. In no case was blame attached to any public association or company undertaking the inspection of boilers. During the 12 months, 19 persons were killed and 45 injured by boiler explosions. In most cases the primary cause of explosion was neglect.

Exhibition of Work.—On Wednesday, June 28th, there is to be opened at the Imperial Institute (North Gallery) by Earl Spencer an exhibition of practical work executed by the students of technical classes in Great Britain, Ireland and the Colonies and by candidates at the City and Guilds of London Institute's Annual Examinations, 1905. The exhibition will remain open until July 8th.

OUR PERSONAL COLUMN.

[*The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* Electrical Review *posted as to their movements.*]

Central Station Engineers.—The Warrington T.C. on June 6th granted the recommended increases of salary which were mentioned in the Electrical Review last week.

The West Hartlepool T.C. has increased the salary of the borough electrical engineer (Mr. Friederichs) from £300 to £325 per annum.

The Luton T.C. has increased the salary of the electrical engineer (Mr. Cooke) from £230 to £260 per annum.

The Kettering U.D.C. on June 7th appointed Mr. W. A. Walker (the present assistant electrical engineer) as electrical engineer at a salary of £175 per annum, increasing by £25 a year to £250.

The Macclesfield T.C. on June 7th appointed Mr. J. H. Woodward as consulting electrical engineer.

We understand that the statement which appeared in this column last week regarding the Johannesburg appointment is incorrect The names of the candidates have not yet been considered by the Council.

Mr. Sheppard has resigned his position as mains superintendent under the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board.

The third annual banquet of the Durban Corporation electricity department was held recently, Mr. J. Roberts, the borough electrical engineer, presiding. The Mayor proposed the health of the department, and, in referring to the excellent services of Mr. Roberts, said that Durban was the best lighted town in South Africa.

Mr. L. Paton Greig, engineer to the Corporation of Bury St. Edmunds, has been appointed engineer to the Richmond and Surrey Electric Light and Power Co., of Richmond, in succession to Mr. M. C. Flemyng, resigned.

The employés of the Glasgow Corporation electricity department held their annual outing on Saturday, the destination being Helensburgh. During the day Mr. W. W. Lackie, the chief engineer, presented Mr. W. A. Chamen, late chief, with a pair of silver candlesticks and a silver inkstand as presents from the employés on the occasion of his leaving Glasgow.

Tramway Officials.—The Tramways Committee of Newcastle-on-Tyne has recommended the T.C. to increase the salary of Mr. Easten, manager of the commercial department of the tramways, by £25 a year.

The Erith U.D.C. has appointed Mr. A. Coveney, general manager and resident engineer of the Ashton-under-Lyne Municipal Tramways, as tramways manager at a salary of £250.

Out of 160 candidates, Mr. J. W. Bamber, traffic superintendent at Halifax, has been appointed tramway manager at Keighley at an annual salary of £110.

The Bournemouth T.C. has appointed Mr. Bulfin, electrical engineer, to act as resident engineer in connection with the construction of the Christchurch tramways, and on their completion to act as electrical engineer for the whole of the Council's system, including the Poole lines, the salary to be £400 a year, rising by £25 per annum to £450. This salary is to include the right of the Council to use Mr. Bulfin's lip rail where required without payment of royalty. The Council has also decided that Mr. Barber, traffic manager, shall also have the management of the Poole undertaking and the Christchurch system on its completion, his salary to be increased from £300 to £400 per annum, rising by £25 a year to £450.

The Dartford U.D.C. has decided to pay £200 to Mr. Tiffin, surveyor, for extra services in connection with the electric tramways.

General.—Mr. R. Wilson, electrical expert, has been re-engaged for a further six months by the Dudley Corporation Electricity Committee. Rather than appoint a permanent engineer, it was deemed wise to retain Mr. Wilson's services until the question of the tramway agreement is settled.

The late Sir Robert Herbert (Telegraph Construction and Maintenance Co.) left estate of the gross value of £39,893, the net personality being £32,797.

The Hon. Reginald Parker has been elected to a seat on the directorate of the Sunderland District Electric Tramways, Ltd.

Mr. W. E. Nash, a member of the staff at the Kent Electric Power Co.'s offices, Chatham, has been presented with a handsome marble timepiece by the staff on the occasion of his marriage.

The Society of Arts Albert Medal for the present year has been awarded to Lord Rayleigh, O.M., Sc.D., F.R.S., "in recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for sound signalling at sea."

According to the *Electrical World and Engineer*, Mr. Frank J. Sprague, with his wife and a large party of friends, recently sailed for England and Europe. It is said that Mr. Sprague will devote special attention to the development of heavy electric traction during his stay here.

The Postmaster-General has appointed Mr. E. Crabb and Mr. H. S. Carey to be assistant secretaries to the Post Office.

Mr. Herbert Austin, of the Wolseley Tool and Motor Co., Ltd., has been elected chairman of the Permanent Committee of the British Empire Motor Trades Alliance.

The *Times* says that Sir Wm. Mulock, Postmaster-General of Canada, arrived in London on Wednesday to attend the Pacific Cable Conference.

The degree of Doctor of Laws has been conferred upon Sir Wm. Mather by the Princeton University, U.S.A.

NEW COMPANIES REGISTERED.

Charlton Syndicate, Ltd. (84,842).—This company was registered on June 5th, with a capital of £7,500 in £1 shares, to adopt an agreement for the acquisition by the company, or its nominees, of the business and assets of Johnson & Phillips, electrical engineers, of Victoria Road, Charlton, Kent, to promote a company for the acquisition of this company's undertaking, and to carry on the business of electrical, telegraph, telephone or general engineers, cable makers and contractors, &c. The first subscribers (each with one share) are:—J. S. Dare, 15, Collingwood Avenue, Muswell Hill, N., secretary; G. T. St. J. Bishop, 143, Faraday Road, Wimbledon, cashier; J. G. Brotheridge, 34, Steedman Street, Walworth, clerk; H. R. Ireland, 1, Stanley Road, South Woodford, book-keeper; A. Govey, 17, Dunbar Road, Forest Gate, clerk; H. A. Nutland, 5, Cathles Road, Balham Hill, S.W., clerk; and J. M. Young, 28, Cressy Road, Hampstead, N.W., clerk. No initial public issue. S. A. Bird is the sole director. Remuneration, 10 per cent. of the net profits.

Catania Electric Lighting and Tramways Co., Ltd. (84,881).—This company was registered on June 8th, with a capital of £1,000 in £1 shares, to construct or acquire tramways, electric lighting works, plant and machinery in Sicily or elsewhere, and to carry on the business of tramway proprietors, suppliers of electric light, electric, mechanical and hydraulic engineers, electricians, carriers of passengers and goods, &c. The first subscribers (each with one share) are:—A. J. Lawson, 4, Adelphi Terrace, W.C., M.I.C.E.; A. Roddick, 4, Adelphi Terrace, W.C., surveyor; G. A. Wilson, 12, Porchester Gardens, W., clerk; A. R. Allen-Lodge, 116, Cambridge Street, Warwick Square, S.W., architect; G. Waterhouse, Park House, Buckhurst Hill, architect's assistant; E. A. Sanderson, 38, Fordel Road, Catford, S.E., accountant; and A. J. Macmaster, 11-12, Clement's Lane, E.C., iron merchant. No initial public issue. Registered without articles of association.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Stanley Electric Carriage Co., Ltd., Chelsea (83,297).—A mortgage debenture, dated June 1st, 1905, to secure £625, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holder: Major-General E. H. Satorius, V.C., C.B., Old Swan House, Chelsea Embankment, S.W.

Auto-Electric Rifle and Target Co., Ltd. (76,336).—Issue, on May 18th, of £50 debentures, part of series created December 5th, 1904, to secure £5,000, charged on the company's undertaking and property, present and future. No trustees. Previously issued of same series: £2,900.

Mann, Egerton & Co., Ld., Electrical Engineers, Norwich, (83,780).—Issue on June 1st of £400 debentures, part of series created April 1st, 1905, to secure £10,000, charged on freehold and leasehold properties in Norwich and Ipswich, and the company's undertaking and property, present and future, including uncalled capital. Trustees: G. F. Buxton, Dunston Hall, Norfolk; and J. J. D. Paul, Eaton Grove, Norwich. Previously issued of same series, £3,700.

Barbados Light Railway, Ltd. (84,394). — £6,000 debentures, created May 11th, 1905, charged on the company's railways, lands, buildings, fixed plant, &c., in Barbados, and its undertaking and general assets, present and future, including uncalled capital (subject to any prior charge in favour of Dick, Kerr & Co., Ltd., on engines, motors, carriages and rolling stock supplied by them). Holder: C. J. P. Carr, Ditcham Park, Petersfield. No trustees.

South African Lighting Association, Ltd. (27,609).—Reissue, on May 24th, of £400, and on May 31st of £1,400 debentures, part of series created August 12th, 1890, to secure £20,000, charged on the company's undertaking and property. Holders: J. W. White, Orchard House, Nailsea, near Bristol; Miss C. Hayes, 10, Woodchurch Road, West Hampstead: Miss E. S. White, Orchard House, Nailsea, near Bristol; W. A. Spurgin, 109, Paynes Road, Freemantle, near Southampton; Mrs. R. M. Cash, Foxcote, Addiscombe Road, Croydon; W. Cash, 90, Cannon Street, E.C.; and A. H. Reed, 64, Mark Lane, E.C. No trustees. Previously issued of same series: £20,000.

ELECTRICITY SUPPLY ACCOUNTS.

West Bromwich Municipal Electricity Supply.

The fourth annual report of the West Bromwich electrical undertaking is very favourable to that concern. With an output some 28 per cent. above the 1904 figure and improved average working costs, which would have been better still but for losses in connection with motor hiring and free wiring, the department earned a gross profit during the year of £4,715, and after meeting financial obligations there remained a balance of £1,328. After deducting from the latter amount the sum of £312 for special allowances, the remainder was carried forward.

The prices charged are:—Private lighting, 4½d. and 1½d. per unit on the maximum demand system; power, 1d.; traction 2d. per unit up to 750,000 units per annum, and 1½d. beyond. The chief engineer is Mr. John H. Wray.

GENERAL STATEMENT.

For year ending March 31st—	1905.	1904.
Total capital expended	£61,024	£56,506
Number of units sold—		
Private supply	330,473	271,096
Public lighting	105,285	42,557
Traction	976,126	791,353
Total number of units sold ...	1,411,884	1,105,006
Equivalent No. of 8-c.p. lamps connected	19,675	12,065
H.P. of motors connected	213	163
Number of public lamps	82	80
Maximum load in kw.	834	788
Revenue Account—		
Gross revenue	£10,765	£9,318
„ expenditure	£6,050	£5,100
„ profit	£4,715	£4,218
Average price obtained per unit—		
Private supply	2·24d.	2·35d.
Public lighting	1·45d.	·91d.
Traction	1·74d.	1·98d.

REVENUE ACCOUNT FOR YEAR, 1904-5.

Gross revenue	£10,765 = 1·83d. per unit.
Works and distribution costs (including public lighting)	£4,745 = ·80d. „
Total working costs	£6,050 = 1·03d. „

PROFIT STATEMENT, 1904-5.

Interest on loans	£2,015
Sinking fund	1,372
Balance on year's working	1,328
Gross profit	£4,715

CITY NOTES.

Utah Light and Railway Co.

The Electric and General Investment Co. acts as trustee for $500,000 of 6 per cent. Collateral Trust Improvement Notes of the Utah Light and Railway Co., of Salt Lake City, U.S.A., and as these notes, and also a considerable number of the bonds and shares of the company are held in this country, the following figures will be of interest:—

JANUARY 1ST TO APRIL 30TH, 1905.

	1905.	1904.
Gross income	$480,263.08	$391,903.32
Less operating, general and maintenance expenses	242,764.48	238,736.32
Net from operating	$197,498.60	$153,166.97

R. Waygood & Co.

The report to be submitted at the meeting at Cannon Street Hotel to-day says that for the year ending March 31st, 1905, the profits, including £6,074 brought forward from last year, amount to £29,339.

Managing director's and directors' fees absorb	£2,800
Dividend on preference shares	8,100
Patent rights, amount written off	500
Further amount placed to reserve	1,400
General reserve account (amount added)	1,000
Interim dividend on ordinary shares	3,375
Leaving a balance of	12,164
	£29,339

The directors recommend that a further dividend be declared at the rate of 13 per cent. per annum for the six months ending March 31st, 1905, making, with the interim dividend already paid, 9 per cent. for the year on the ordinary shares, which will require £8,775, leaving a balance of £3,389 to carry forward.

Babcock & Wilcox, Ltd.

The directors have issued a circular to the shareholders in connection with the proposed modification in the reserve fund and capital account referred to at the recent meeting. They submit that, as the extension of the business requires employment of increased working capital, and as the reserve fund has accumulated to an amount that admits of it, they place before the shareholders the means of readjusting the capital and reserve fund accounts by making a distribution out of the reserve fund of £265,000 at the rate of 10s. per share to the holders of ordinary shares. It is intended to create 270,000 new £1 ordinary shares. It is proposed to offer 265,000 ordinary shares of £1 each at par to the shareholders in the proportion of one new share for every two ordinary shares. An extraordinary general meeting was held in London yesterday, altering the articles of association and increasing the capital of the company to £900,000 by the creation of 270,000 new ordinary shares of £1 each, to rank *pari passu* with the existing ordinary shares.

Hindhead and District Electric Light Co.

The second annual meeting was held last week, Mr. J. Grover presiding. The report showed that the total outlay for land, buildings, plant and cables, has been £12,634, and that 11,000 fully paid-up shares had been issued. The number of customers at present on the company's books is 66, an increase of 17 since last year.

The CHAIRMAN said he was sorry that the hope of paying a dividend had not been fulfilled. The station had been running for 4½ years, and had not earned a dividend; but he hoped that such a result would not occur again. It was, however, clear that it did not pay the company to make electricity in small quantities. The company's gross earnings had been £1,412, and their working expenses £1,417, which left a small loss to carry to next year's accounts. Their working expenses had been kept as low as possible. They had no costly staff to maintain, no directors' fees, while their secretary's salary was only £20, and their managing director's £20 below that. The total of their salaries and wages was £202; coal and oil cost £327, and the balance, £208, covered rates, repairs, and insurance. It would have been easy to have paid a small dividend, at the expense of the depreciation fund, but, in his opinion, 7½ per cent. of the value of plant and machinery was too little to set aside for depreciation; it should at least be 10 per cent. A machine might not be worn out at the end of 10 years' use, but, compared with an up-to-date machine, it might be so costly to work and maintain, that it would be wiser to sell it for what it would fetch, or even to consign it to the scrap heap. As proof, he might point out that already their two steam sets, erected only in 1900, were found too expensive to work, and they were proposing to keep them only for contingencies. Last year they put down a 40-H.P. engine, and they had now ordered another of the same kind, but giving 80 H.P. He thought that unless they extended their cables to Haslemere, this new addition would give them all the power they would need for the next two years. The total cost of the additions to their plant was a little over £2,000, but he himself would take up additional shares to that amount. A few of their customers had complained of the price of current (viz., 8d. per unit), but even at that figure the company was unable to earn a dividend, and he failed to see how the price could be reduced. The company could greatly increase their output at the cost of a small addition to their working expenses. A reduction in price was made to large consumers, and power for use in motors was sold at only 4d. per unit. They were not in the position of a municipality owning an electric plant, who could put the cost of working upon public lighting, or upon their works department, or upon the rates. He had heard of one large borough which credited its electric department with 4s. per head of the population for public lighting. In his opinion, the amount credited should not be above 1s., judging from another borough where the light was supplied by a company. When municipal accounts were audited by independent chartered accountants (as they were likely to be before long), it was his impression that there would be a panic in the electrical departments, and a great rise in the price of current to consumers. They had one cable a mile in length which only supplied five houses with light.

[We give a brief description of this undertaking in our "Lighting and Power Notes" this week.]

Kabelfabrik Actien Gesellschaft, of Pressburg.

The report for 1904 of the Cable Works Co., of Pressburg and Vienna, which has a share capital of 2,400,000 kronen, recommends the payment of a dividend at the rate of 7 per cent., or 28 kr. per share, being the same rate as in the previous year. As compared with 1903, the accounts show a slight increase in the profits, although this is not due to an improvement in the general condition of business, as the profits did not advance in the same proportion as the sales, while the greater turnover was only obtained by continued competition abroad. The directors record with satisfaction the fact that orders were received from individual industrial undertakings in Germany, as well as from various Prussian railway administrations for block, signal and telegraphic cables, and the greater portion of the orders have already been delivered. In addition to these, considerable cable orders were received for Spain, Belgium and Russia, and although those for Ghent and Riga are included in the balance-sheet, they will only be settled in the current year. A site adjoining the Pressburg Works has been acquired, and the new factory at Vienna was expected to be opened last April. During the year the company was employed by both the Austrian and Hungarian Governments in accordance with the amount of the credits voted, and if the credits proposed for 1905 are carried, large orders are also expected for the current year. Most of the cable networks ordered by municipal authorities and companies, both at home and abroad in the past year have already been laid; only those for Leoben, Portschach, Saragossa, and the Buda-Pesth tramway, as well as an installation for the Belgian State railways, had to be postponed until 1905, owing to the continued unfavourable weather.

The patent account, which has apparently been written down by 10 per cent. per annum, appears for the last time, and unless further inventions are acquired this item will not appear in the balance-sheet for 1905. The total income amounted to 1,410,805 kr., and after meeting working expenses, taxes and interest charges and providing for depreciation, there remains a surplus of 245,174 kr. This sum has allowed of the payment, after placing 5 per cent. to the reserve fund and providing for directors' fees, &c., of a dividend at the rate of 7 per cent., with 37,943 kr. carried forward.

Electric and General Investment Co.—The directors recommend the following dividends, &c., for the year ended May 31st, 1905:—Ordinary shares—A dividend of 4s. per share, of which 1s. per share was paid on account in January last, leaving 3s. per share to be distributed. The trustees for the ordinary shares reserve fund propose to distribute out of the dividends received 1s. per share, making a total present distribution of 4s. per share, or 20 per cent.; or a total distribution of 5s. per share, or 25 per cent. for the year. On the founders' shares a dividend of £20 per share for the year ended May 31st, 1905, is proposed, and the trustees for the founders' shares reserve fund propose to distribute out of the dividends received £10 per share, making a total distribution for the year of £30 per share. The above-mentioned payments will be subject to the deduction of income-tax.

Newcastle and District Electric Lighting Co.—Letters of allotment and regret for the issue of £150,000 4½ per cent. debenture stock have been posted.

City of Wellington Electric Light and Power Co.—The directors have declared a dividend on the ordinary shares of the company at the rate of 10 per cent. per annum for the half-year ended December 31st, 1904 (making 7½ per cent. for the year), and after placing £5,000 to a reserve and contingency account, £2,044 remains to be carried forward.

Montreal.—A Glasgow paper says that arrangements are being made for the amalgamation of the companies operating the Montreal street railways and light supply. The projected amalgamation is for the purpose of economy in plant. No obstacle thus far has been presented to the merger, and it is believed that it will take place shortly.

Stock Exchange Notices.—Applications have been made to the Committee to allow the following securities to be quoted in the Official List:—

Adelaide Electric Supply Co., Ltd., 10,000 6 per cent. cumulative preference shares of £5 each £3 paid.

Eastern Extension, Australasia and China Telegraph Co., Ltd.—Further issue of £150,000 4 per cent. mortgage debenture stock (perpetual).

The Committee has appointed special settling days as under:—

Wednesday June 21st.—British Columbia Electric Railway Co., Ltd.—£15,000 preferred ordinary stock, representing preferred ordinary shares, Nos. 83,501 to 85,000.

Friday June 23rd.—British Columbia Electric Railway Co., Ltd.—Further issue of £85,000 preferred ordinary stock, representing preferred ordinary shares, Nos. 65,501 to 74,000, and £90,000 deferred ordinary stock.

And ordered same to be quoted in the Official List.

National Telephone Co.—The transfer books of the 3½ per cent. and 4 per cent. debenture stocks will be closed from the 17th to the 30th inst., inclusive, for the preparation of the warrants for the interest due July 1st.

Telephone Co. of Egypt.—The register of transfers of 4½ per cent. debenture stock will be closed from June 17th to 30th.

British Aluminium Co.—Letters of allotment for debenture stock and ordinary shares are stated to have been posted.

STOCKS AND SHARES.

Wednesday Evening.

However near peace prospects are, the realisation of them is regarded by the Stock Exchange as still a good way off, and the early spurt in prices quickly gave place to a duller sentiment as no fresh buyers came along. The week being somewhat broken by the Bank Holiday and the Stock Exchange settlement, some excuse may be advanced for the non-appearance of business, while the renewed meddling of the Kaiser with Moroccan affairs alarmed the French, and caused heavy sales of various securities popular in Paris. Hence Consols are dull, and hence the general sympathy of other investment departments with the premier security.

For all this, we hear of several new issues that are shortly to be placed before the public, and the most important has to do with a certain London tramway company for whose finances we have not the highest respect. Its ever-widening sweep of extension creates the need for further capital, and if £300,000 of 4 per cent. Debenture stock at about 98 should be offered to existing proprietors, no surprise would be felt. This may forthcome in about a month's time. Then there is the new Oriental Telephone Debenture to appear shortly, and the present shareholders in the company may be treated to a 4 per cent. stock offered in the region of 92. As a guess, we should say that the Metropolitan Electric Tramways might ask before long for money, but the company has, of course, recently raised funds by an issue of Ordinary shares. Its opening the other day of a new section to Whetstone shows that the undertaking is making rapid progress with this particular work. The South Metropolitan Electric Co. is, we believe, contemplating an issue of shares and Debenture stock.

By a most unhappy misfortune, the newly-opened Sunderland District Electric Tramway Co. had a serious accident to one of its cars this week, and claims for compensation will, no doubt, figure for a heavy sum in the next balance-sheet. The shares of the concern are practically unmarketable in London at present; dealings will come when the company is more firmly established. South Wales Electric Power shares have almost dropped out of the active list, although the Debenture stock commands a good premium.

In the railway department, there is the usual fall to notice in City and South London Ordinary, again down to 40. Central Londons have not altered from 92, 102 and 81½ for Ordinary, Preferred and Deferred stocks respectively. District Railway remains at 37½, and a new electrified section is now in operation. Metropolitans are 93½. Great Northern and Piccadilly Debenture and Charing Cross Debenture are 50 per cent. paid-up, and the prices continue at their par value. Baker Street and Waterloo Debenture stands at 100½.

Several of the Metropolitan Electric Lighting shares show an improving tendency. Westminster Preference rose ¼ to 6½, City of London Preference are ¼ up at 14¼ (despite the Gas Light and Coke competition), and Metropolitan Ordinary jumped ½ to 10 upon persistent buying. South Metropolitan Preference lost $\frac{1}{16}$, and Central Electric 4 per cent. Debenture dropped a point to 103½. Inquiry is still made for the prior charges of the Edison & Swan; the 4 per cent. Debenture has risen 1, and so has the 5 per cent. Second Debenture.

Interest in Telegraph securities is still upon a very quiet scale, and there are no movements of importance to notice. West India and Panama Second Preference re-developed weakness, receding 10s. to 5½, but this is the only change in the group. Commercial Cable 4 per cent. Debenture added ½ at 98½, and Submarine Cables Trust has put on another point at 126½, both improvements due to a little demand from the American railroad department. No alteration has occurred in the Eastern or the Anglo-American Telegraph Co. divisions, except a 10s. rise in Anglo "B" to 105. British Insulated Preference came on offer, and fell ¼ to 5⅞, but Telegraph Constructions keep firm, and the holding on account of a prominent proprietor, who is now deceased, is not expected to come to market, at all events for the present. There is a rise of 2 in British Aluminium 5 per cent. Debenture stock, although the Preference shares at 5 are ¼ lower.

The traction market has become inanimate. Anglo-Argentine are better at 8$\frac{9}{16}$, the Preference staying at 6¼, and Barcelonas maintain their improvement at 13. London United Preference are 10¼, the fraction being represented by the dividend due in two or three weeks' time. Westinghouse Preference at 2$\frac{11}{16}$ have again declined. A rumour is current to the effect that the American company has just secured an enormous order amounting to a "million"; whether dollars or sterling is meant we do not know. Perhaps it scarcely matters—to shareholders in the English undertaking.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1902.	1903.	1904.	Closing Quotations June 7th.	Closing Quotations June 14th.	Business done week ended June 14th, 1905. Highest.	Lowest.
34,800	African Direct Telegraph, 4 % Debs.	100	4 %	4 %	4 %	100 —103	100 —103	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	2¼— 2⅜	2¼— 2⅜	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	85 — 90	85 — 90	..	..
763,580	Anglo-American Telegraph	Stock	60/6	61s.	23/32	59 — 61	59 — 61	..	..
3,118,210	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5 15/16 %	105 —106	105½—106⅛	106	105½
3,118,210	Do. do. do. Deferred	Stock	1/-	2s.	Nil	15⅛— 15⅜	15⅛— 15⅜	15 11/16	15½
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	..	6⅜— 6⅝	6⅜— 6⅝	..	..
15,000,000$	Commercial Cable	$100	8 %	8 %	8 %	.. ..	.. ..	..	..
1,932,856£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	4 %	4 %	4 %	97 — 99	97½— 98½	98	..
16,000	Cuba Telegraph	10	6½	10 %	5 %	8 — 8½	8 — 8⅝	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	16 — 17	16 — 17	..	..
12,931	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	3⅜— 3⅝	3⅜— 3⅝	..	..
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	8½— 9	8½— 9	..	..
30,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	101 — 103	102 —104	103½	..
60,710£	Direct United States Cable	20	3½%	3 %	..	11⅛— 11⅜	11⅛— 11⅜	11⅜	11¼
78,500	Direct West India Cable, 4½ % Reg. Deb., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	100 —102	101 —103	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	141 —144	141 —144	143½	142½
2,000,000	Do. 3½ % Pref. Stock	100	3½%	3½%	..	90 — 92	90 — 92	91⅝	90
1,836,814	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	107 —109	107 —109	..	..
300,000	Eastern Extension, Australiasia, and China Telegraph	10	7 %	7 %	7 %	13¾— 14¼	13¾— 14½	14 3/16	14
602,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	105 —107	105 —107	..	..
300,000	Eastern & South African Tele., 4 % Mt. Db., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	100 —102	100 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	100 —102	100 —102	..	..
180,887	Globe Telegraph and Trust	10	£3 16 7*	5⅜ %	5⅜%	10½— 10¾	10½— 10¾xd	10¾	10 5/8
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	14½— 14⅝	14½— 14¾xd	14⅝	..
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	24 %	33½— 34½	33½— 34½	34¼	33¾
50,600	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	100 —102	101 —103	102½	..
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	49 — 51	49 — 51	..	..
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	..	¾— ⅞	¾— ⅞	..	..
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	111 —112	111⅜—112½	112	111¾
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	103 — 105	102 —104	103½	102½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12½— 13½	12½— 13½	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11½— 12½	11½— 12½	..	..
250,000	Do. do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5¼— 5⅝	5½— 5⅝	5⅝	..
2,000,000	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	100—102	100½—102½	101¼	101
1,689,593	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	103 —105	103—105	104¼	104
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6¾%	6¾%	1⅛— 1¼	1⅛— 1¼	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	6 %	6 %	6 %	1⅛— 1¼	1⅛— 1⅜	..	..
100,000	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	99 —102	99 —102	..	..
11,839£	Reuter's	8	5 %	5 %	5 %	7½— 8 xd	7½— 8	..	..
3,237	Submarine Cables Trust	Cert.	6 %	6 %	6 %	124 —127	125—126	..	..
58,000	United River Plate Telephone	5	7 %	8 %	..	6¾— 7¼	6¾— 7¼	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	..	5 — 5¼	5 — 5¼	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	108 — 110	108 —110	..	..
15,609£	West African Telegraph, Shares	10	2 %	4 %	4½%	8 — 8½	8 — 8⅝	..	..
30,008	West Coast of America, 1 to 30,000 and 53,001 to 53,008	2½	Nil	Nil	Nil	⅜— ½	⅜— ½	15/32	..
150,000	West Coast of America, 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	100 —102	100 —102	..	..
207,930	Western Telegraph, Ltd., Nos. 1 to 207,930	10	7 %	7 %	7 %	13¼— 14	13¼— 14	14	13¾
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	101 —103	101 —103	..	..
563,380	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	103 —105	103 —105	104½	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	⅛— ⅝	⅛— ⅝	..	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	6 %	7 — 7¼	7 — 7¼	7⅛	7 1/16
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	5¾— 6¼	5¼— 5¾	5¼	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	104 —106	104 —106	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

40,000	British Aluminium 7 % Cum. Pref.	5	Nil	Nil	Nil	5 — 5⅛	4¾— 5¼	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	4⅛— 5⅛	4⅛— 5⅛	5⅛	5 1/16
20,000	Do. do. 4 % Funding Certs.	5	..	..	..	2⅛— 3⅛	2⅛— 3⅛	2 1/16	..
300,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	98 —102	100 —104	..	..
133,301	British Electric Traction	10	8 %	6 %	..	9¼— 9⅝	9¼— 9⅝	* 9⅝	5/8
156,437	Do. do. 6 % Cum. Pref.	10	6 %	6 %	..	11¼— 11⅝	11¼— 11⅝	11⅝	11 1/16
1,000,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	5 %	5 %	5 %	122 —124	122 —124	123¼	122½
250,000	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	97 — 99	97 — 99	98½	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	5⅝— 6	5⅝— 6	5⅝	5 5/8
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	5¾— 6¼	5¾— 6	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	102 —105	102 —105	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	9/16— 11/16	9/16— 11/16	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	Nil	⅜— ½	⅜— ½	½	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	1⅜— 1⅝	1⅜— 1⅝	1⅝	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	92 — 95	92 — 95	94½	94
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	79 — 82	79 — 82	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	10 — 11	10 — 11	10 1/16	..
40,000	Do. do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5¼— 5⅜	5¼— 5⅜	..	..
300,000	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	107½—109½	107½—109½	..	..
1,963,208	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	91 — 93	91 — 93	92⅜	..
523,396	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	101 —103	101 —103	101	..
523,396	Do. do. Def. do.	Stock	4 %	4 %	4 %	80 — 83	80 — 83	..	..
1,330,000	City and South London Railway	Stock	3½%	2⅝%	2⅝%	40 — 42	39 — 41	40	..
85,000	Crompton & Co., Nos. 1 to 85,000	3	5 %	2½%	..	1⅞— 2⅛	1⅞— 2⅛	1 31/32	1⅞
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	95 —100	95 —100	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	Nil	Nil	..	1½— 1⅝	1½— 1⅝	..	..
17,139	Do. do. "A" shares, 01—017,139	5	Nil	Nil	..	2 — 2⅛	2 — 2⅛	2 1/16	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	83 — 88	84 — 89	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	88 — 93	85 — 90	..	..
112,100	Electric Construction 1 to 112,100	£2	6 %	4 %	..	⅞— 1⅛	1⅛— 1⅜	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	£2	7 %	7 %	..	2¼— 2⅜	2¼— 2⅜	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	4 %	4 %	4 %	96 — 99	96 — 99	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9⅝— 10⅛	9⅝— 10⅛	..	..
200,000	Do. do 4 % Mort. Deb.	Stock	4 %	4 %	4 %	97 —101	97 —101	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	11¼— 12⅛	11¼— 12⅛	12 1/16	12
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	5⅜— 5¾	5⅜— 5¾	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	109 —111	109 —111	109⅝	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	15½— 16½	15½— 16½	16 1/4	16
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1⅛%	1⅜%	1¼%	3¼— 3⅜	3⅜— 3½	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	9¼— 9¾	9¼— 9¾	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	33 — 35	33 — 35	34	..
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	103 —105	103 —105	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3⅛%	3⅛%	3⅛%	90 — 92	90 — 92	90	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 2½ per cent. (March 9th, 1905).

SHARE LIST OF ELECTRICAL COMPANIES *(continued)*.—ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1902.	1903.	1904.	Closing Quotations June 7th.	Closing Quotations June 14th.	Business done week ended June 14th, 1905. Highest	Lowest.
		‡							
29,377	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 %	10 %	10 %	9⅜—10¼	9⅜—10¼	..	..
10,623	Do. do. 7 % Cum. Pref. ..	5	7 %	7 %	7 %	9½—10⅜	9½—10⅜	..	..
288,782	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	103 —106	103 —106 xd	..	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	7⅞— 8⅛	7⅞— 8⅛	..	..
80,000	Do. do. do. 4½ % Cum. Pref. ..	5	4½%	4½%	4½%	5⅛— 5⅜	5⅛— 5⅜	5⅜	..
40,000	Do. do. " City Undertaking " 4½ % Cum. Pref. ..	5	4½%	4½%	4½%	5 — 5¼	5 — 5¼	..	..
40,000	Do. do. 1903	5	..	4½%	4½%	5 — 5¼	5 — 5¼	..	..
350,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	109 —111	106 —108	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	4½%	5⅝%	6 %	6⅜— 6⅝	6⅜— 6⅝	6½	..
150,000£	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	109 —111	109 —111	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595.. ..	10	5 %	5 %	6 %	10½— 11¼	10½— 11¼	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	13⅜— 14⅝	14 — 14⅝	14⅝	14⅛
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	5 %	5 %	5 %	124 —128	124 —128	126⅝	124⅛
300,000	Do. 4½ % 2nd Deb. Stock, Prov. Certs., all paid	100	4½%	4½%	4½%	104 —106	104 —106	104⅛	104¼
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	8⅜— 9	8⅜— 9	..	..
30,000	Do. do. do. 6 % Pref., 40,001—60,000 ..	10	6 %	6 %	6 %	12 — 12½	12 — 12½	12⅜	..
400,000£	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	113 —116	113 —116	103⅜	..
250,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	103 —105	103 —105	104	103⅜
70,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	5⅝— 6¼	5⅝— 6¼	6⅛	5⅛
80,000	Do. do. 6 % Cum. Pref.	..	6 %	6 %	..	6 — 6¼	6 — 6¼	6¼	6⅛
300,000£	Do. do. 4½ % 1st Mort Deb. Stock ..	100	4½%	4½%	4½%	107 —109	107 —109	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12 %	12 %	11½— 12¼	11½— 12¼	11⅝	..
136,000	Do. do. do. 4 % Debenture Stock ..	Stock	4 %	4 %	4 %	101 —103	101 —103	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	2 — 2⅛	2 — 2⅛	2⅛	..
60,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	5 — 5⅛	5 — 5⅛	..	..
371,895	Do. do. do. 4 % 1st Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	99 —101	99 —101	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8⅜%	10 %	9⅛— 9⅜	9⅛— 10¼	9⅜	9⅛
76,121	Do. do. 4½ % Cum. Pref. 1—71,106, £3 paid ..	5	4½%	4½%	4½%	5⅛— 5⅜	5⅛— 5⅜	5⅜	..
220,000£	Do. do. 4½ % 1st Mort. Deb. Stock	..	4½%	4½%	4½%	111 —115	111 —115	..	..
250,000£	Do. do. 3½ % Mort. Deb. Stock Red.	Stock	3½%	3½%	3½%	98 —100	98 —100	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	99 —101	99 —101	100⅛	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	14¼— 15½	14¼— 15½	..	..
59,000	Do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	100 —102	100 —102	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	13⅝— 14¼	13⅝— 14¼	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	8⅜— 9	8⅜— 9	..	..
150,000£	Do. do. do. 3½ % Deb. Stock Red. ..	100	3½%	3½%	3½%	98 —100	98 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	2⅝— 3⅛	2⅝— 3⅛	2¾	2 11/16
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	79 — 83	79 — 83	..	..
65,000	South London Electricity Supply, Ord.	5	12½%	3 %	4 %	3⅜— 4¼	3⅜— 4¼	..	..
100,000	South Metropolitan Electric Light and Power { Ord	1	Nil	Nil	Nil	3/16— ¼	3/16— ¼	..	..
50,000	*(Late Blackheath and Greenwich* { 7 % Pref. ..	1	Nil	7 %	7 %	1⅛— 1⅛	1⅛— 1⅛	1⅛	..
100,000	*Dist. E.L.Co.)* { 4½ % 1st Deb. Stock	100	4½%	4½%	4½%	105 —108	105 —108	..	..
30,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	4⅛— 5	4⅛— 5	4⅛	..
30,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5⅛— 5⅜	5⅛— 5⅜	..	..
200,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	100	..	..	4½%	104 —106	104 —106	..	..
110,000	Westminster Electric Supply, Ord.	5	12 %	13⅓%	14 %	12 — 13	12 — 13	12⅞	12⅛
28,151	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	6 — 6½	6½— 6⅝	6⅝	6 1/16

Shares not officially quoted :—Mackay Companies, ord., 39½—40. Pref. 73¾—74½.

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, June 14th.

	CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a	Acid, Hydrochloric	per cwt.	5/-	..
a	,, Nitric	per cwt.	22/-	..
a	,, Oxalic	per cwt.	32/-	..
a	,, Sulphuric	per cwt.	5/6	..
a	Ammoniac, Sal	per cwt.	42/-	..
a	Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a	,, ,, ...	per ton	£30	..
a	Bleaching powder	per ton	£5 5	..
a	Bisulphide of Carbon	per ton	£15	..
a	Borax	per ton	£13	..
a	Benzole (90 %)	per gal.	7/-	..
a	,, (50/90 %)	per gal.	5/6	..
a	Copper Sulphate	per ton	£20	..
a	Lead, Nitrate	per ton	£25	..
a	,, White Sugar..	per ton	£31	..
a	,, Peroxide	per ton	£27 10	..
a	Methylated Spirit	per gal.	2/6	..
a	Naphtha, Solvent (90 % at 160° C)	per gal.	5/6	..
a	Potassium Bichromate, in casks	per lb.	3d.	..
a	Potash, Caustic (75/80 %) ..	per ton	£22	..
a	Potassium Cyanide	per lb.	7½d.	..
a	Shellac	per cwt.	150/-	5/- dec.
a	Sulphate of Magnesia	per ton	£4 10	..
a	Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a	,, Recovered	per ton	£5 10	..
a	,, Lump	per ton	£5	..
a	Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a	,, Crystals	per ton	£3	..
a	Sodium Bichromate, casks ..	per lb.	2¾d.	..
a	,, Cyanide	per lb.	7d.	..
	METALS, &c.			
b	Aluminium Ingots, in ton lots ..	per ton	£130	..
b	,, Wire, in ton lots ..	per ton	£168	..
b	,, Sheet, in ton lots ..	per ton	£166	..
b	Babbitt's metal ingots	per ton	£43 to £140	..
c	Brass (rolled metal 2" to 12") basis	per lb.	7¼d.	..
c	,, Tube (brazed)	per lb.	9½d.	..
c	,, ,, (solid drawn).. ..	per lb.	8¾d.	..
c	,, Wire, basis	per lb.	7¾d.	..
c	Copper Tubes (brazed)	per lb.	10¾d.	..
c	,, ,, (solid drawn) ..	per lb.	10¾d.	..
g	Copper Bars (best selected) ..	per ton	£80	£1 inc.

	METALS, &c. *(continued)*.		Latest Price.	Fortnight's Dec. or Inc.
g	Copper Sheet	per ton	£80	£1 inc.
g	,, Rod	per ton	£80	£1 inc.
e	,, (Electrolytic) Bars ..	per ton	£70 10	..
e	,, ,, Sheets ..	per ton	£87	..
e	,, ,, Rod ..	per ton	£81	..
e	,, ,, H.C. Wire	per lb.	9¼d.	..
j	Ebonite Rod	per lb.	3/3	..
	,, Sheet	per lb.	3/-	..
n	German Silver Wire	per lb.	(1/6)	..
h	Gutta-percha, fine	per lb.	6/- to 7/-	..
h	India-rubber, Para fine	per lb.	5/7½ to 5/8½	dec.
i	Iron, Charcoal Sheets	per ton	£18	..
i	,, Pig (Cleveland warrants)	per ton	45/3	6d. dec.
i	,, Forgings, according to size	per ton	From £11	..
i	,, Scrap, heavy	per ton	47/6 to 50/-	..
i	,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g	Lead, English Ingot	per ton	£13 5 to £13 7 6	2/6 inc.
g	,, ,, Sheet	per ton	£15	5/- inc.
m	Manganin Wire No. 28	per lb.	8/-	..
g	Mercury	per bot.	£7 7 6	..
d	Mica (in original cases) small ..	per lb.	6d. to 1/-	..
d	,, ,, ,, medium	per lb.	2/6 to 4/-	..
d	,, ,, ,, large ..	per lb.	4/6 to 8/6	..
p	Phosphor Bronze, plain castings	per lb.	1/1 to 1/3	..
p	,, rolled bars & rods	per lb.	1/1 to 1/3	..
p	,, ,, strip & sheet	per lb.	1/3	..
o	Platinum	per oz.	82/6	..
e	Silicium Bronze Wire	per lb.	10½d. to 11½d.	..
i	Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i	,, ,, in bars		£15 to £40	..
g	Tin, Block	per ton	£138 to £138 10	30/- to 40/- inc.
n	,, Wire, Nos. 1 to 16	per lb.	1/8	..
p	White Anti-friction Metals— " White Ant " brand	per ton	£43 to £65	..
j	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j	,, 6 lea. Flax	per lb.	5⅝d.	..
j	,, 3 ply 10 lbs. Russian ..	per lb.	4½d.	..
j	,, 10 lbs. Russian, single ..	per lb.	4¼d.	..
j	,, 180 lbs. Jute rove ..	per ton	£11	..
k	Zinc, Sh't (Vieille Montagne bnd.)	per ton	£26 17 6	10/- inc.

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons, Ltd.; *d* F. Wiggins & Sons; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

Bridgewater Gas Power Station.—Mr. I. William Chubb, in *Power*, gives a description of this station as laid out by Messrs. Pressland & Frippard and the Sir Hiram Maxim Co. for lighting and power purposes. There are two three-cylinder vertical Westinghouse gas engines supplied with gas from two Dowson producers of the pressure type. The engines are direct coupled to 100-KW. generators. Electric ignition is employed, and the speed of the engines can be adjusted, while running, over a range of 5 per cent.; compressed air at 240 lb. per sq. in. is employed for starting. One of the engines drives a 100-KW. direct-current generator at 250 r.p.m. and 500 volts, while the other engine has two 50-KW. dynamos of 250 volts. These machines are connected in series across the outers of the three-wire lighting system. A booster-balancer is also installed, consisting of four Westinghouse standard S.B. machines, the two inner machines being balancers and the two outer boosters. The latter will raise the pressure from 230 to 340 volts, while the two balancing machines are capable of an output of 25 KW. at 250 volts. There are also 260 accumulator cells capable of supplying 50 amperes for seven hours for lighting purposes only. The gas generators each serve engines of 150 B.H.P., and can be worked together or separately as required by the load, the guaranteed consumption being not more than 1¼ lb. of gas coke per B.H.P.-hour at full load, or 1 lb. of anthracite. Anthracite beans cost 14s. to 15s. per ton at Bridgewater. With plant of similar type at Walthamstow, of 1,650 B.H.P., the costs per unit last year were:—Fuel, ·34d.; oil, waste and water, &c., ·19d.; wages, ·33d.; repairs and maintenance, ·03d.; total, ·89d.

COMMERCIAL MANAGEMENT OF MUNICIPAL ELECTRICAL SUPPLY.

By T. W. SHEFFIELD, A.M.I.E.E., A.M.I.M.E.

The rapid development of the electric lighting industry since the introduction of the Electric Lighting Act of 1888 is too apparent on every hand to need specifying. Nevertheless, had anyone, at the time of the passing of the "Act" ventured to predict such a future for the industry, his statement would probably have been heavily discounted, if not severely ridiculed, by the most sanguine expert of that time. Yet the fact remains, that notwithstanding the enormous capital already expended, our local authorities, with the sanction of the Local Government Board, are at the present time raising some millions of money.

In London alone the outlay on the part of the Borough Councils or their predecessors has amounted to £6,000,000, and this sum is continually being added to on account of extensions. In this connection it will no doubt be interesting to compare the outlay of capital and the returns of several of the chief provincial cities up to the end of the last financial year.

Total Expenditure at End of Year, 1904.

Manchester.	Liverpool.	Newcastle-on-Tyne.	Glasgow.
£2,110,432	£1,718,713	£1,147,405	£1,119,048

Edinburgh.	Leeds.	Sheffield.
£845,537	£752,509	£740,943

Financial Results—Surpluses.

Manchester.	Liverpool.	Newcastle-on-Tyne.	Glasgow.
£31,809	£44,510	£14,046	£42,522

Edinburgh.	Leeds.	Sheffield.
£23,997	£3,430	£5,430

The total of the sums for seven towns mentioned, out of some 170 municipal electrical undertakings (from the smallest, costing from £20,000, to the larger ones, costing £650,000) represents a formidable expenditure, and the tendency is to considerably increase this from time to time as necessity demands.

Could we obtain the exact profits accruing from these undertakings after allowing for the usual disbursements, they would doubtless prove to be of exceptional interest, and although this is not possible, it will illustrate our purpose to enumerate the capital expenditure and dividends paid by some of the more important companies in London, which also go to show what might be expected from some of our municipal undertakings.

Name of company.	Total expenditure at end of year.	Year.	Financial results; surpluses.	Last dividend declared.
Metropolitan ...	£1,539,582	1904	£122,904	10 %
St. James'	438,326	1904	36,147	14½ %
Westminster	1,015,480	1904	84,221	14 %
County of London ...	1,300,089	1903	32,598	4½ %
Kensington	355,144	1904	18,986	12 %
City of London ...	2,037,238	1903	55,595	6 %
Charing Cross ...	923,814	1903	34,029	8 %
Notting Hill	224,267	1904	11,663	7 %
Chelsea	454,854	1904	15,101	6 %
The Brompton ...	233,669	1903	22,069	10 %

From the foregoing it will be seen that electric light undertakings have developed into a highly profitable business, the most favourable returns being obtained by those companies situate where hotels, clubs, theatres and restaurants are numerous, which is naturally the only outlet these companies have, as there are few, if any, industries to supply in such districts.

These returns may be taken as fairly representative of what electric light companies can accomplish for their shareholders, in densely-populated or large business centres, and although no doubt there will be lesser dividends earned by companies in less favourable positions than those mentioned, it may be reasonably assumed that when the conditions are favourable, electric supply companies can, and do, make profitable returns on the capital expended.

It can be gathered from the figures we have before us, that the returns of the municipal undertakings compare very unfavourably with those of the electric supply companies, especially when we take into account that the local authorities have a large maximum output for the tramway system. No doubt this state of affairs will continue to exist until the municipal supply departments wake up and take full advantage of the unique position they hold as suppliers of electricity for lighting and power.

The reason for such poor returns is not far to seek, inasmuch as municipal undertakings with few exceptions are conducted with a certain amount of what one may term municipal apathy. This business laxity is only spasmodically questioned by public opinion, and even then it soon lapses into its normal state after the usual criticism by the Committee and Press reports on the Councils' methods.

Notwithstanding this, and although fresh innovations are somewhat difficult to introduce into municipal undertakings, it is gratifying to hear that some of the chief engineers of our electrical departments are taking the lead in appointing a representative to further their interests with actual and prospective customers on their mains. The result is soon apparent in an increased output from their stations. We quite appreciate the fact that the chief engineer of any fairly large municipal electric supply undertaking has quite sufficient to occupy his time and attention in looking after the efficiency and maintenance of the plant, not forgetting the committee. Yet it is a regrettable fact, that until quite recently the advantages of their supply have not been brought before the general public as prominently as could be desired, and the undertaking has, from a financial standpoint, suffered accordingly. There is no doubt that had the electrical departments of our municipal undertakings looked after the commercial side of their supply, in anything like the same proportion as the engineering side, many of our provincial undertakings would be in a more prosperous condition than they are in to-day.

Hitherto this question has been practically left entirely in the hands of the contractors, which is quite in order so far as the installation goes, but the writer has no hesitation in saying that in the majority of cases their advocation of the advantages of the uses of electricity, would not receive the same consideration or support as that from a qualified representative of a municipal electrical supply department.

The main duties of such an official would be to point out the benefits of electricity for lighting and power purposes, at the same time giving a commercial table of costs for the different purposes of supply. No doubt some will consider that this form of canvassing for the electricity department is unfair competition with the municipal gas undertaking, but this is not so when taking into consideration the strenuous endeavours of some of the Gas Committees to keep pace with electric light as an illuminant.

Apart from this, the gas department hire out gas stoves at a very cheap rate per 1,000 cb. ft. per quarter, and make a considerable reduction to industries taking a large quantity of gas for power purposes, and in one case under the writer's notice, are willing to hire out a gas engine, evidently a copy of the system of hiring out electric motors, so successfully adopted by many of our electrical undertakings.

What a field this at one time presented to the gas undertakings! And even now there is a considerable opening in certain cases where the gas engine can compete very successfully against the electric motor, especially when the gas mains are laid to the point of demand, and where it would involve considerable capital outlay in mains to obtain a limited supply.

It will, therefore, be seen that each question of the different supply depends upon the merits and circumstances of the case, and that competition is just as healthy for municipal departments as it is for individual firms.

From the foregoing it will be seen that it is practicable and reasonable for any fairly large municipal electrical undertaking to appoint a duly qualified commercial manager, under the chief engineer; his main function would consist in directing his assistants, if required, in obtaining consumers to take up the electric supply for lighting or power.

The above case would of course only apply to stations with an output of say anything above 4,500 KW.; even with this load, local conditions, and the nature of the industries

would have to be taken into consideration. Under this and in smaller undertakings no doubt one capable representative could control the commercial side of the electrical supply department. In the very small undertakings it would be quite practicable to pay a small bonus per lamp, to one of the clerks, when business in the station became slack, or in the summer months during the light loads. In this connection the rough sketch of report card shown, with plan of mains on the back, would be useful in keeping a concise record of customers on the mains.

BISPHAM CORPORATION.

ELECTRIC SUPPLY DEPOT.

INDEX CARD No. _____

PARTICULARS OF CONSUMER	*J. Smith, Chemist,* *45, Market Street.* *Tel. No. 4160.*		
PARTICULARS OF INSTALLATION	VOLTAGE. *220*	No. OF LAMPS. *50 16-C.P.*	ARCS. *10 5-Amp.*
	FANS. *1 12″*	MOTORS. *1 2-H.P.*	

REMARKS _____

TERMS OF SUPPLY _____

CONTRACTOR *W. Fielding & Co., Birley Street, Blackpool.*

INTERVIEW BY *H. Cruse.*

INSTALLATION PASSED BY *J. Lowe.*

EXAMINED BY *J. Lowe.*

DATE			
1.2.'05			

GENERAL REMARKS _____

FOR PLAN OF MAINS SEE OVER.

In this respect it is interesting to note that when work becomes slack in some of the large American works, and the office staff is not fully employed, several of the clerks in a department requiring more work, are sent out to obtain orders. They become for the time being representatives, and there is certainly something to be said in favour of this system. It gives the inside workers an opportunity of learning the conditions of securing business, and encourages interest in the success of the department. Apart from this, it teaches them to appreciate sound business when it is secured.

When corporations adopt this method of securing increased loads for their stations, there will be plenty of applicants for the positions, and it is to be desired that Municipalities and their chief engineers when appointing a supply manager or representative, will only select those who have had a thorough commercial training in the electrical industries. No doubt there will be the usual outcry from the public, of additional expense, when municipal bodies adopt this system, but the good returns accruing from such a policy will soon silence all objection, and those who take the initiative will certainly have the pleasure of seeing many others follow in their footsteps.

The most striking illustration of the foregoing policy which the writer met with during six years' association with municipal undertakings, occurred in a modified form in connection with a town where the yearly contract for motors had been secured. In this case an assistant was appointed to secure orders for motors, &c., discussing at the same time the advantages of securing his firm's motors on the hire system from the Corporation, and the extra time devoted to this scheme was well repaid, for within the 12 months over 350 H.P. in motors was added to the station load, this being quite apart from the current supplied for lighting. When it is taken into account that this load was secured without the direct support of the Corporation, it forcibly points out what a duly appointed representative of the Corporation could reasonably secure, and thus materially assist in using the maximum output available, bringing in its train successful financial results to the undertaking.

From general observations it is agreed that the controllers of municipal undertakings must take a keener insight into all matters relating to the commercial side of their supply. What may be expected by adopting this course is a material growth of the ordinary lighting business, stimulated by a considerable increase in the supply of power for various branches of trade. By this is meant industrial establishments in general, entirely apart from the tramway supply.

THE HYDRATE THEORY OF SOLUTIONS APPLIED TO ELECTROLYTES.

THE hydrate theory of conducting solutions, as expounded by Dr. T. M. Lowry at the Faraday Society on May 18th, represents a compromise between the original dissociation hypothesis of Arrhenius and the old hydrate theory of Mendeléef and Pickering, of which Prof. Armstrong in this country has been so powerful an advocate. The dissociation hypothesis, as everybody now knows, supposes that when a salt is dissolved in water so as to form an electrolyte, some or all of the molecules of the solute are split up into free positive and negative ions; for example, in the case of common salt into $\overset{+}{Na}$ and $\overset{-}{Cl}$. In dilute solutions it is supposed that the dissociation is complete, and this finds strong support from the classic measurements of Griffiths, who has shown that while the freezing points of solutions of a non-electrolyte, such as sugar, are very accurately those deduced from the gaseous value of the osmotic pressure, those of very dilute solutions of potassium chloride give exactly double values, thus indicating that the molecule has been split up into two parts. There are two great difficulties in the way of accepting the ionic hypothesis in its simplest form. First, it entirely neglects the presence of the solvent and the greater or less affinity which obtains between it and the solute, reducing its rôle, in fact, merely to that of a *medium*, in which the ions can migrate; secondly, it fails, as Armstrong has insisted, to suggest a *motive* for dissociation. The hydrate or association theory, on the other hand, which in its early form supposed that the chief result of adding water to a salt was to form a series of hydrates, fails to take into account the well-known properties of electrolytes; in particular, the phenomena of migration and the results obtained by Griffiths in his freezing-point determinations, as explained above. The theory which was explained to the members of the Faraday Society by Dr. Lowry with such admirable lucidity, is essentially a combination of the dissociation and association theories. It still supposes that some of the molecules of the solute are dissociated, but it postulates that the ions so formed are not free, but are associated with molecules of the solvent—let us say water—to form hydrated ions. In Dr. Lowry's form of the theory the hydration of the ions is the *primary* cause of the ionisation of aqueous electrolytes. It is supposed that in a very strong solution the molecules only are, for the most part, hydrated. Then, as further water is added, the fully-loaded molecule can take up no further water by itself, so it splits into two hydrated ions, and in that way more complete hydration (and, therefore, presumably a maximum of potential energy in the solution) becomes possible. Obviously, the ions are, therefore, jointly combined with a larger quantity of water than the molecule from which they are derived, for it is an essential postulate of the theory that the ions have a greater affinity for the solvent than has the molecule. As more and more water is added,

more molecules become ionised, and, in complete accordance with observation, it is only in the presence of a very large excess of water—conditions which Dr. Lowry shows to be most favourable to the formation of complex hydrates—that complete ionisation becomes possible.

It would be impossible here to dwell at any great length on the rest of the evidence which Dr. Lowry has collated in support of this modification of the hydrate theory; but we will briefly indicate the more noteworthy points in what is actually a very weighty chain of evidence. We have first to note that the best ionising solvents are those which are themselves most highly associated, as would be expected if "association" were the primary cause of ionisation. The most striking evidence, however, adduced by Dr. Lowry is that afforded by a consideration of the mobilities of the various ions in aqueous solutions. Thus, if one considers the ionic mobilities of, say, the lithium series of elements, it will be found that the ion of the light metal lithium, whose atomic weight is 7, moves through the solution only half as rapidly as the ions of rubidium or cæsium, whose atomic weights are 85 and 133 respectively; or, in general, the larger atoms in this series yield the more mobile ions. This lends strong support to the view that the ions are loaded in some way, and are not free as originally supposed by Arrhenius. The theory affords an elegant explanation of an anomaly long known to occur in the molecular depression of the freezing point caused by dissolving an electrolyte in water. In very dilute solutions this depression is double what it is in the case of a non-electrolytic solution of the same molecular concentration, since in the former case the molecule is replaced by two ions. But if the simple ionic hypothesis were true, as the concentration of an electrolytic solution is increased, the molecular depression should diminish steadily until, in concentrated solutions, it approached that of non-electrolytic solutions of the same concentration. But as a matter of fact, in many cases the depression of freezing point actually reaches a minimum value at a certain concentration, and then increases again with the concentration—the molecular conductivity, and therefore the ionisation, all the time steadily decreasing. The result necessitates the assumption of combination between the solute and the solvent, by which a part of the solvent is rendered negligible as far as the lowering of freezing point is concerned, and as the increase of molecular depression takes place at very low concentrations, when the salt is almost entirely ionised, this combination must occur between the ions and the solvent, rather than between molecules and the solvent.

One vital question remains. Why has the solvent a greater affinity for the ions than for the molecule? Dr. Lowry's tentative solution of this problem is not, we think, entirely convincing. He somewhat ingeniously suggests that the process of hydration of the ions may be analogous to the condensation of water vapour round gaseous ions, the discovery of Wilson. But molecules are electrically neutral, and it is difficult to see why their constituent ions in combination should attract round themselves clusters of molecules of the solvents. Dr. Lowry further suggests the possibility of there being in the molecule of solute a kind of residual chemical affinity, which is greater in one of the ions than the other. This, perhaps, seems more feasible, but the question will have to remain unanswered for the present. The key will probably be found in some application of the electron theory to the elucidation of this and other outstanding difficulties of theories of electrolysis. Perhaps Prof. J. J. Thomson will one day turn the searchlight of his genius in this direction.

The hydrate theory of ionisation lends itself very readily to extension to the cases of electrolytic conduction by fused salts and by solids, such as the Nernst filament. It is well known that fused volatile compounds, and compounds which are liquid at ordinary temperatures, are usually insulators in the pure state. Such substances are but very slightly associated. On the other hand, fused salts which easily conduct are just those which are characterised by polymerisation—the associative formation of complex molecules. Dr. Lowry's theory supposes that these heavily-loaded groups of molecules can easily break up *in between* the ions of their constituent molecules, and thus will be formed independent ions associated with neutral molecules of the salt. In fact, just as a solution of potassium chloride will contain ions represented by

$$\overset{+}{K}\,(H_2O)_x,\ \overline{Cl}\,(H_2O)_y,$$

so fused potassium chloride will contain the corresponding ions

$$\overset{+}{K}\,(K\,Cl)_x,\ \overline{Cl}\,(K\,Cl)_y.$$

Lorenz and Fausti have actually shown experimentally that in fused mixtures of lead chloride and the alkali chlorides the lead is present in the form of a complex anion which travels in the opposite direction to the current.

The Nernst lamp consists of a mixture of oxides, and like glass has the composition of an electrolyte. It can only become a conductor, however, when sufficiently heated to allow of ionic migration taking place. It is difficult to prove directly that the Nernst filament conducts electrolytically—possibly because of the action of the air in reversing the effects of electrolysis—although it is known that polarisation of a kind takes place. But there is strong indirect evidence on this point, since the concentration-conductivity series of curves for mixtures of zirconium and yttrium oxides at various temperatures are almost identical in form with the curves yielded by mixtures of sodium hydroxide in water. It is a not unreasonable conclusion that the mechanism of conduction is similar in the two cases.

There is, of course, nothing essentially novel in the hydrate theory of dissociation. Werner seems to have suggested the idea as far back as 1893, and Mr. Whetham in his reply to the discussion on the very first Paper read before the Faraday Society (1903) said that "ions, in fact, may be linked in some way to the solvent." But Dr. Lowry has now for the first time considered the whole question of electrolytic conduction from the "hydrated-ion" point of view, and he has collected and codified in a convenient and accessible form all the disjointed experimental evidence in its favour that various workers have, from time to time, published. The Paper of Mr. Whetham just referred to, on "The Present Position of the Theory of Electrolysis," Prof. Kahlenberg's recent Faraday Society Paper, "Recent Investigations Bearing on the Theory of Electrolytic Dissociation," and the present Paper by Dr. Lowry, form together the most complete statement of modern views on the nature of electrolysis, looked at from all points of view, that has up to the present been published in English.

REVIEWS.

Traité Théorique et Pratique d'Electricité. By H. Pecheux, with additional notes by A. Blondin and E. Neculcea, and preface by J. Violle. Paris: Librairie Ch. Delagrave. 1904. Price 17 fr.

This is a ponderous tome of over 700 pages, bound in paper covers, after the frugal Continental fashion, and traverses the whole range of electrical science, from electrostatics to the transmission of power. In his prefatory note, M. Violle refers to a tendency which exists in France, as with us, to decry one's own country's achievements and to exalt those of the foreigner; and he justly claims for the technical instruction given in the French schools a high standard of excellence. The book before us represents in the main the course of instruction in electrical technology which is pursued, under the direction of the author, at the Ecole Nationale d'Arts et Métiers d'Aix. The author has not hesitated to make use of mathematical treatment where this is necessary or advisable, though he points out that those who are unfamiliar with the processes employed may make use of the results and pass over the derivation thereof; to assist them in this judicious skipping, the difficult work is printed in small type. A further evidence of the influence of the modern commercial spirit is found in the inclusion of the prices of apparatus described in the industrial section of the book, a feature which we think worthy of imitation.

As for the contents of the work, these are so diverse that

we cannot refer to them in detail. The theory of electrostatics is first elaborated, occupying the whole of the first part of six chapters. Electrodynamics is dealt with in the second part, and includes the theory of magnetism. This section is very comprehensive, embracing 10 chapters, which form the bulk of the book, and ranging from the frog's leg experiment of Galvani to polyphase alternators of 1,000 KW. The third and remaining part deals with the industrial applications of electricity, in five chapters.

The only fault we have to find with the work is that it is too comprehensive, too detailed, and contains too much that is of historical interest only. It will be seen, therefore, that we accuse the author of giving too much, not too little. We wonder how his students get through so vast an amount of work, and we congratulate them upon sitting at the feet of so industrious and learned a preceptor.

Steam Pipes: their Design and Construction. By W. H. BOOTH. London: Arch. Constable & Co. Price 5s. net.

That Mr. Booth is no friend of the ring system of steam pipes is already known to us; but what shall we say of the following sentence culled from his most recent book:—"Steam engineers . . . . . insist on the use of the best materials so as to minimise the chance of failure rather than countenance the duplication of bad work which has arisen from want of knowledge of steam engineering conditions and an apparently foregone conclusion that breakdowns are necessary, and must be encouraged to occur by provision of a maximum of parts to fail." The percussive force of this dictum is sufficient to shatter any ring system in the country. In every part of his book Mr. Booth is quite as explicit, and the whole work forms a useful manual on a subject which has not hitherto, so far as we are aware, been treated separately in book form. The various formulæ constructed to express the relation between velocity of flow of steam, its pressure drop, the quantity delivered, and the pipe-length and diameter are first stated. In another edition these might be improved in statement and typography. Taking one demonstration as an example (Rankine's approximate formula on p. 5, by the way, is incorrectly printed, as the whole expression should have been bracketed under the root sign; there is also a symbol for temperature-degree after g, the value of gravity, which is obviously an error) the scheduled quantities T_2, k, U_1, U_2, are not used in the formula. What impression does "$\gamma = 1{\cdot}3$" convey to the ordinary reader? The formula on p. 8 should read $D = 0{\cdot}36\sqrt[5]{}$ &c., the radical ^{5} having been omitted. After this, the proper employment of the various materials in use for steam and exhaust piping is discussed, an attempt at standardising such dimensions as flange-thicknesses, the number and size of bolts, and sizes of crosses and tees, being made. Under this heading, by the way, Mr. Booth recommends the use of flexible metallic pipes, made of a peculiarly folded strip of metal (either steel, zinc, copper, or a bronze alloy) coiled into a closely interlocked helix, whose interstices are made steam-tight by asbestos. No guarantee is given as to the durability of these pipes, but engineers are told to bear them in mind for temporary work, or where strains are set up by the settlement of a bad foundation or other cause. This is a departure from established practice which will doubtless be hastened by Mr. Booth's advocacy of it. A chapter on expansion gives types of the expansion bends and joints in use, and deals with the proper anchoring of pipework. Sections on the strength of pipes, their support and jointing, are followed by a chapter on the erection of pipes, in which a very neat but, in our opinion, rather daring method is described, of affixing a saddle and drilling into a high-pressure steam-pipe (even while steam is passing) for the purpose of adding a branch line to an existing pipe system without stoppage of supply. After a discussion of the general arrangement of pipework, the author passes to the accessories of the pipe, such as valves for steam and exhaust, and isolating valves for boilers; steam traps, separators, automatic atmospheric valves, and exhaust heads. In addition to dealing in more detail with the standardisation of junction pieces and flanges, weights of pipe, and the kinetic theory of gases in relation to the flow of steam, he gives us a chapter labelled "Superheated Steam," which would more properly be described as a section on pipe coverings, since one page devoted to the former subject is followed by rather over 18 on the latter. In an appendix, the gist of the report of the committee appointed to consider the standardisation of pipe flanges is given.

If we may venture a complaint at an otherwise excellent book, we would take exception to what appears to us to be a rather erratic arrangement of chapters. For example, the section on weights of pipe is sandwiched between tests on pipe coverings and a discussion of the kinetic theory of gases, whereas we should have expected it somewhere in the neighbourhood of the chapter on materials used in pipe construction. Again, the chapter on weights and dimensions of junction pieces and flanges appears to have lost its moorings when it is found between a section on steam-traps and one on separators, its rightful sphere being in the same group as "materials" and "weights of pipe." And should not the "kinetic theory of gases" have preceded the formulæ for flow of steam, instead of posing as an afterthought at the end of the book? On going through this book one has the same feeling of discontinuity as when, on reading a novel, one has to abandon the hero at a thrilling situation and the close of a chapter, to pick up some other character whose existence had been forgotten. The practical result is that one has to search the book to ensure the collection of all information on any one subject. The book is evidently compiled from notes made by a busy engineer in the midst of his work, and is hence of much value.

INSTITUTION OF ELECTRICAL ENGINEERS.

ALTERNATING-CURRENT MOTORS IN INDUSTRIAL SERVICE.

By P. D. IONIDES.

(*Abstract of Paper read at Glasgow on May 9th*, 1905.)

A GOOD deal of attention is now directed towards the alternating-current motor with a view to accomplishing as good results in all classes of power-driving as have until recently been considered practicable only by the use of direct-current motors.

The conditions here are now becoming very similar to those abroad, inasmuch as the large power distribution companies are increasing in number and scope, and also many large municipalities are adopting alternating currents for transmitting power from central stations to sub-stations, where the current is converted for lighting purposes.

In the author's opinion such municipalities as Glasgow, Manchester, Liverpool, &c., will shortly offer alternating current for power purposes at a lower rate than direct current, for the reason that the converting apparatus for a large alternating-current motor load is less expensive.

With these changes taking place it seems advisable to consider the application of the alternating-current motor to all sorts of industries, and with particular reference to such cases where it has been the general opinion that only direct-current motors could be used.

The great argument in favour of the alternating-current motor, particularly of the squirrel-cage type, is its simplicity and the absence of wearing parts. The almost universal argument used against the alternating-current motor, as compared with the direct-current, shunt-wound machine, is that it has not the advantage of shunt regulation for variable-speed work. It is true the speed of the induction motor cannot be varied in this way, but there are other ways in which different speeds can be obtained with equally high efficiency, and the author is inclined to think that the importance of being able to vary the standard shunt-wound motor 10 per cent. or 15 per cent. is frequently very much over-estimated.

The constant-speed type of motor can be built so that it will carry 200 per cent. overload with a comparatively small drop in speed, or by changing the proportions of the windings in the secondary the motor can be made to give its maximum torque at starting.

The slip-ring motor differs from the squirrel-cage motor only in the secondary, which is coil-wound, the windings being connected to three slip-rings for starting with resistance in the secondary circuit. Once the motor is started, and the secondary short-circuited, its characteristics are similar to those of the squirrel-cage type.

For starting up against very heavy loads, where gradual acceleration is required, this motor is preferable to the squirrel-cage type; moreover, starting against a given load, the starting current is not so heavy, and more closely resembles the results which can be obtained with the ordinary direct-current motor starter and shunt or compound-wound motors.

The single-phase series motor differs materially from the other types, inasmuch as it is not what is generally known as an "induction motor." This type more nearly resembles the direct-current series motor, and possesses both commutator and brushes; in fact, it will operate quite satisfactorily on a direct-current supply. This motor is nothing more than a direct-current series motor constructed to operate satisfactorily with rapid reversals of polarity.

Squirrel-cage motors up to 10 H.P., obtaining their supply from a power station of 200 H.P. or 300 H.P., can be started up direct without the use of auto-transformers. This does not injure the motors in the least, but is not advisable where the generating plant is of small capacity as compared with the motors, inasmuch as it takes a very heavy rush of current at starting. It is also advisable to use a double-throw switch for the purpose of cutting out the fuses at starting, otherwise the fuses, being of sufficient capacity to withstand the starting current, would be of no practical value as fuses, once the motor was started and the current down to normal.

A third arrangement for starting the squirrel-cage motor is from a closed-coil two-phase generator, which is worthy of consideration when planning a new industrial plant.

It is frequently stated that the squirrel-cage motor is incapable of starting up against full load. This is quite incorrect, for as much as three times the full-load torque can be developed at starting, while in the smaller sizes 2 to 2½ times the full-load torque can be developed; but, at the same time, the current to obtain such starting torques would be very heavy. To obtain a starting torque equivalent to full-load torque it requires roughly 2½ times full-load current in almost all sizes of motors, but as this requirement is only momentary, it is of little consequence.

For general constant-speed work the squirrel-cage motor possesses the advantage of greater simplicity, and has no disadvantages as compared with the direct-current motor. For driving spinning machinery it is particularly suitable by reason of the fact that within certain limits the speed is constant in relation to the speed of the generating plant, and independent of slight fluctuations in voltage. Again, in spinning mills and such industries it is of the utmost importance that all machinery should be started simultaneously. The squirrel-cage motor lends itself to this requirement very readily, as it is possible to leave all the motors in an installation connected direct to the line, and to start them all simultaneously by separately exciting the generator and then running up the engine.

For mining work, such as the driving of pumps, fans, and underground haulages, the squirrel-cage motor is particularly suitable, inasmuch as there are no parts other than the bearing requiring attention; again, the oil-immersed auto-starter, which can be made water and gas tight, is a form of starting switch which needs no skill or knowledge in handling. In many pits where there are explosive gases no other type of motor could be used with the same safety.

The high lift turbine pump is gaining considerable popularity amongst mining engineers, and for driving this type of pump direct the squirrel-cage motor is particularly suitable, inasmuch as motors of 100 H.P. and above are frequently required, running at a speed of 1,400 to 1,500 r.p.m. A direct-current motor of this power and speed would not be a satisfactory machine to build or operate; but for this work the squirrel-cage motor presents no difficulties, provided a supply is available at a suitable frequency.

A valuable feature of the squirrel-cage motor, not previously mentioned, lies in the fact that it can be actually stalled by overload for as long as half a minute without damage.

For the driving of large haulages which must be started slowly and gradually, the slip-ring motor is preferable. Any starting torque required, within reasonable limits, can be obtained without producing undue strain on the generating plant; in fact, with the slip-ring motor the proportion of current to torque developed by the motor is almost similar to the same proportion for shunt-wound direct-current motors.

For continual starting and stopping, the slip-ring motor possesses considerable advantages over direct-current motors for this class of work. It is general to use a tramway type controller in each case, and whereas with the direct-current motor the currents broken by the controller are always at line pressure, with the slip-ring motor the currents broken are those in the secondary circuits of the motor, and at a low pressure. This feature adds to the life of the contacts.

Again, for electric braking the slip-ring motor can be used to great advantage, by so proportioning the resistance in the secondary circuit with the first or second notches of the controller as to produce a gradual braking effect when the controller is reversed. This has been applied with marked success to a 150 H.P. slip-ring motor driving an endless haulage.

The industries most generally requiring variable-speed motors having a wide range of speed are those connected with the making of paper, printing, dyeing and bleaching. In some cases the speed variation required is so wide and so gradual as to preclude the possibility of using "induction motors," and until the recent development of the single-phase series motor there was no alternating-current apparatus which could meet these requirements.

In the majority of cases, however, the requirements of speed variation can be met by the use of induction motors of either the squirrel-cage or slip-ring type.

These requirements can be met in the following manner:—

There is a small auxiliary motor driving the main motor through a worm gear and free-wheel clutch, so as to give the required slow speed. The main motor is wound and connected to a controller of the tramway type, so that the coils of the stator can be grouped to form eight poles, at which the medium speed would be obtained, or four poles, at which full speed would be obtained.

The changing from dead slow to half speed, and from half speed to full speed, is obtained by means of tappings from a pair of auto-transformers and a number of notches on the controller, whereby a gradual increase in voltage is applied to the motor as the controller is moved from notch to notch. This ensures an even acceleration.

The whole apparatus is no more costly than direct-current apparatus to accomplish the same results would have been, and the operation is equally satisfactory.

The output of the motor is varied in direct proportion to the change in speed, but the efficiency at any speed is as high as it is possible to obtain within a very small percentage. As the power required to drive most machinery varies directly as the speed at which it is driven, the output of the motor corresponds very nicely with what is required of it.

There are classes of work where it is necessary for the motors to have a speed variation of perhaps 6 or 8 to 1, with the possibility of being able to run continuously, and with high efficiency, at any intermediate speed. This requirement is principally found in connection with paper-making machinery, and in some cases with calico printing, bleaching and dyeing.

The direct current apparatus for this purpose has always been more or less expensive, and difficult to design.

The single-phase series motor offers a method of accomplishing this result which is simpler and more efficient. The apparatus for this purpose will consist of a single-phase motor controlled by an induction regulator, which is a boosting transformer placed in series with the motor.

Any required voltage from zero to full line pressure can be applied to the motor, and consequently any required speed can be obtained. The losses in the induction regulators are simply the magnetisation and C^2R losses.

For variable speed work, where constant stopping, reversing and starting again is required, both the squirrel-cage motor and the slip-ring motor may be used.

With the former, the control is effected by applying different voltages to the primary by means of auto-transformers and a controller. For this service the resistance in the secondary should be increased so that the maximum torque is obtained at zero speed by constructing the end rings, to which the bar windings are bolted, of metal having a higher resistances than that used in the construction of the constant-speed, squirrel-cage motor. The torque of this motor varies as the square of the E.M.F. applied to the primary.

By means of the auto-transformers and the controller, any voltage can be applied so as to give the required torque and speed.

With the slip-ring motor, the control is effected by varying the resistances in the secondary circuit of the motor, and this method of control corresponds to inserting resistances in the armature circuit of a shunt-wound motor.

For operating winches, live rolls, and work of this class, the slip-ring motor is preferable for the reason that, in the first place, the starting currents are not so heavy, and in the second place, the currents handled by the controller are all in the secondary circuit, and consequently at a low pressure, which results in less burning of the contacts.

The efficiency of polyphase induction motors corresponds very closely to the best results obtained with direct-current motors.

The power factor is the ratio of the true power to the apparent power expended, as shown by an ammeter; it is high at heavy loads and low at light loads. The lagging current has an injurious effect on the regulation of the generator, transmission lines, or transformers. It is important, therefore, to maintain the power factor as high as possible.

From the standpoint of the user, the alternating-current apparatus is probably the cheapest both in first cost and maintenance.

Discussion.

The Chairman remarked that he was particularly interested and surprised to find it so clearly stated that the cost, as well as the efficiency of the alternating current motor, was as favourable, if not more so, than the direct current. They were all accustomed to think that the D.C. motor was the only possible means of doing certain work—particularly the extreme variation of speed required for paper plant.

Mr. H. A. Mavor remarked that there could be no doubt that the points which Mr. Ionides raised were such as they could cordially subscribe to. Until now the development of alternating current work had been in connection, principally, with polyphase motors, but it was interesting to find that the polyphase motor showed signs of being only a passing phase in a development. That being so, it did not emerge that there was a conflict between the continuous current motor and the alternating current motor, because the two machines were in all essential particulars alike. But he thought it was quite possible in discussing this matter to strain the argument to an extent which would prevent them from following Mr. Ionides throughout. It seemed to him that the speed control of polyphase motors was not a straightforward and simple thing. They were tied down to multiples of speed and to specific speed much more closely than with the continuous current. He thought that in all factories where polyphase machinery was being manufactured, continuous current motors were still used for a large number of purposes, because they were found more convenient to handle, and easier to apply to a large number of details than the polyphase motors. From the manufacturers' point of view, he greatly wished that the continuous-current motor and everything else but the polyphase motor was abolished.

Mr. H. B. Maxwell said he did not suppose there was any other class of work where polyphase motors would show to such great

advantage as in shipyards, where the work was rough and tumble. To his mind the three-phase induction motor was most useful for extremes. For fixed speed work there was nothing to compare with it.

Mr. W. B. Hird thought that Mr. Ionides claimed for the squirrel-cage motor more than could be obtained from it, but he agreed with the author that the capabilities of the D.C. motor for variable speed work had been greatly exaggerated.

Dr. Henderson agreed with the main conclusions of the paper, and said that if electrical men were more conversant with alternating current work, the A.C. motor would have a much greater popularity.

Mr. Stevenson said that the very best direct-current motors gave trouble in the course of time; when one went in for a three-phase system he got rid of the commutator and the starting switch. The polyphase motor was suitable for extremes.

Mr. Ionides, in his reply, said that Mr. Mavor had referred to the single-phase series motor as a possible means of doing away with polyphase motors; he could not say that he agreed with that. The single-phase series motor had a particular field, and if one could construct a motor of the squirrel-cage type without commutator or slip rings, it was something to stick to until they could get one without bearings. Mr. Mavor also referred to the future of single-phase motors for electrical traction, and there was little doubt that there was a great future ahead for those motors, particularly for suburban traffic. He cordially agreed with what Mr. Maxwell said as to shipyard work. He thought that a great many people, in looking out for new plant, were more apt to consider the variable speed requirements of a few cases than the constant speed requirements present in the great majority of cases.

THE EDDY CURRENT BRAKE.

In opening the discussion on the paper read at Birmingham on April 12th by Messrs. D. K. Morris, Ph.D., and G. A. Lister,

Mr. Henry Lea said that he considered that a mechanical brake might be devised which could be attached to the motor spindle, and which would be equally satisfactory and less costly than the eddy current brake described.

Dr. Sumpner (Chairman) thought that supporting the whole brake on the motor spindle was a very beautiful device. He considered that the brake combined the theoretical accuracy of the Pony brake with the simplicity and convenience which resulted from the use of a generator as a load. The authors had developed a new form of theory in connection with this brake, based on the law which had been stated by Maxwell, but which had been very seldom applied. He was struck by the similarity of the curve showing variation of torque with flux displacement, with that connecting the torque and slip of an induction motor.

Mr. Marples did not consider the Hopkinson method as altogether satisfactory. The eddy current brake was an ideal method of absorbing power for time tests to determine heating.

Mr. Chattock remarked that the brake described was simple, handy, and very suitable for small powers. If, however, it were made sufficiently large to absorb 30 or 40 H.P., he thought it would become too cumbrous and costly on account of the energy which had to be supplied during the test.

Mr. Ossettich gave an account of his experiences with previous types of eddy current brake. He had had trouble in connection with the centring of the disk and the heating of the magnetising coils. The most important thing in connection with the type of brake described by the authors was the method of putting it on the motor shaft. The weak spot was the amount of energy consumed. He considered that the theory might be applied to the design of the brake disks used in meters.

Mr. Holden said that he had had considerable experience with the eddy current brakes used on meters, but with these one never reached a speed at which the weakening of the field became noticeable, so that the retarding torque was always practically proportional to the speed. It seemed incredible that the power absorbed should be proportional to the speed only, and not to the square of the speed, but the authors had made this quite clear in the paper. He noticed that in fig. 3 the pole-pieces were shown as having bevelled edges; he had found plain poles much better. With reference to the authors' statement that the braking effect depended merely upon the total flux cutting the copper, he did not think that they would have got such a good braking effect had they used two instead of eight poles. In connection with meter disks, he had experimented upon the best shape of pole-piece; with equal area and flux density, he found the circular shape produced an effect greater than that caused by the square pole in the ratio of 8 to 7, and that the rectangular shape was much inferior to either.

Mr. Brew was much interested in the way in which the authors had shown that the braking effect depended on the speed and resistance of the brake disk.

Mr. Bate said that the authors' brake would be a valuable adjunct on all testing floors. He had been impressed by the sweetness with which the brake worked.

Mr. M. B. Field (written communication) said that the authors attempt to calculate the drag in a copper disk moving in a magnetic field, was interesting, and should prove helpful to others. The authors' assumption that all the lines of force emerged from the surface of the disk at the same angle, was only tenable when the path of the eddy currents was a straight radial line. This would be the case were the edges of the disk infinitely conducting, and were the induction, normal to the disk, uniform at all points in the radial line. In the authors' case the normal flux density varied from point to point of a given line of eddy current flow, the electric potential would in general not be constant, and it was no longer possible to assume that all the flux lines left the surface parallel with each other. A particularly suggestive point was the critical thickness of the disk which gives maximum braking effect. Instead of varying the thickness of disk, the authors might have varied the specific resistance. It would be interesting to have some tests with cast-iron disks of the appropriate thickness to give maximum eddy current loss at some safe speed, and to study the effect of the superposed hysteresis drag. A second noticeable point was the similarity of the curve in fig. 11 of the paper to the torque slip curve of an induction motor. In connection with meter damping disks, it was a mistake to suppose that circular pole-pieces gave the best results, as the eddy currents do not circulate round the poles, but traversed them. If a narrow rectangular pole face be used, the braking effect is much greater when the disk is moved across the face, than when moved in the direction of the length of the face.

Mr. Alfred Schwartz, in a written communication, said that the authors were to be congratulated on the ingenuity of their methods, and the workmanlike appearance of their brake. The cradle dynamometer method of testing, as an alternative to the eddy current brake, was worth considering, particularly for use with larger machines than those dealt with by the authors. In the Municipal School of Technology, Manchester, they used a cradle dynamometer for motor testing designed by Mr. A. E. Moore, and made in the School shops. It consisted of an adjustable base plate radially suspended from two beams with hollow trunnions on ball bearings. A counterpoise was provided on the cradle for adjusting the centre of gravity of the oscillating system. The torque was preferably measured by a zero method, as this eliminated any error due to the centre of gravity of the cradle and motor not being coincident with the axis of oscillation. This was effected by the use of a spring balance or a weighted lever. With a belt drive, machines could be rapidly put in position and run on the ordinary commercial tests, with the advantage that the B H.P. could be obtained at any time during the run. The cradle was also suited for the determination of the mechanical and electrical losses, starting torque and other detail tests.

Mr. C. F. Smith, in a written communication, remarked that in using eddy-current brakes, he had found the easy method in which the load was adjusted to any desired value, to be a great advantage. Thus, in taking a complete efficiency curve of a motor, the sliding weight on the arm of the brake could be adjusted to an exact point on the scale, and the pull of the brake then adjusted by means of a finely divided rheostat in the exciting circuit of the brake, until the motor exactly balanced the load. The same advantage of easy adjustment, made itself still more felt when it was desired to load the motor rapidly up to a certain definite point—say the normal full load of the motor.

Prof. D. Robertson wrote to express his interest in the paper. He had lately used a mechanical brake of the James Thomson pulley type, which he had found convenient for the testing of small motors. This was a rope brake, one end of the rope being attached to a frame carried on the pulley. The torque was balanced by a weighted cord passing round a portion of the frame in the form of an arc struck from the centre of the pulley. The motion of the frame round the pulley, which was limited by stops, adjusted the arc of contact to suit the coefficient of friction within considerable limits. The load for any given torque was thus automatically kept constant. He had made a brake of this type suitable for machines up to 10 B H.P., and had found it to work satisfactorily, there being practically no hunting.

Dr. Morris, in reply, considered that the similarity of the torque-speed curve for the brake to that of the induction motor, was perhaps apparent rather than real. An essential feature of the former was the reduction in flux due to its obliquity and the consequent increased length of passage through the air-gap; while in the induction motor, the flux was substantially constant on account of the constancy of the applied voltage. It was lag of induced currents rather than reduction of flux which caused the falling-off in torque of an induction motor, when the slip was great. There was no limit from constructional reasons to the size of this type of brake; in fact, the larger it was made, the more economically it could be designed. The real limit was imposed by the need for saving the power spent in driving the motor when this exceeded, say, 15 to 30 B.H.P.—*i.e.*, when the Hopkinson method became fairly applicable. Mr. Holden's remarks upon the influence of the shape of the pole-pieces were of great interest in connection with the design of the brake. In reply to Mr. Brew, it appeared that there was only one best thickness for the brake disk for a given speed. He was much gratified by the way in which this new form of electric brake had been received, and by the appreciation expressed for the authors' efforts to give a working theory for the design of such brakes.

Mr. Lister also briefly replied.

PHYSICAL SOCIETY.

The meeting on May 26th, 1905, was held at the National Physical Laboratory by invitation of the director, Dr. Glazebrook. The following special demonstrations were shown:—

"The Specific Heat of Iron at High Temperatures," by Dr. J. A. Harker. A knowledge of the specific heat of iron is important in the determination of high temperatures by calorimetric methods. Dr. Harker has determined the total heat of iron up to temperatures of 900° C. by heating the specimen in an electric furnace, the temperature of which was determined by a resistance thermometer, and

dropping the iron into a water-calorimeter. A difficulty arises at high temperatures owing to the oxidation of the iron when it comes in contact with the water in the calorimeter, and it is necessary in these circumstances to enclose the specimen by a suitable shield. Quartz tubes were tried, but it was invariably found that they splintered when immersed in the calorimeter. The difficulty was overcome by having in the calorimeter a vertical cylindrical brass tube, filled with magnesia, terminating at its upper end in a hemispherical cup. The iron, in the form of a cylinder, the diameter of which was slightly less than that of the tube, was dropped into the magnesia. The extreme flocculence of the powder allows the iron to go straight to the bottom of the tube, and it is thus protected from oxidation. Dr. Harker illustrated by curves some of the peculiarities of the specific heat of iron at high temperatures.

Dr. Harker also exhibited some new types of electric furnace for the attainment in the absence of noxious gases of temperatures between 800° C. and 2,200° C. The conductor conveying the electric current is a tube of solid electrolytes similar in composition to the filament of a Nernst lamp. An essential feature is that, for many purposes, the usefulness and life of a furnace constructed in this way may be much increased by adopting a "cascade" system of heating. That is, the energy supplied may be divided, so that only sufficient is put through the tubular conductor to raise its temperature, say, 1,000° C. above its surrounding, the surrounding itself being maintained at 1,000° C., thus enabling a temperature of 2,000° C. to be attained in the tube without straining it unduly. The regulation of temperature in small furnaces of this type is so perfectly under control, that very well defined melting-points may be taken with very small quantities of substance. The thermo-electric method has been used in these furnaces for determining the melting-point of platinum, the mean result of the experiments giving 1,710° C. ± 5° C.

Mr. A. CAMPBELL exhibited apparatus for the measurement of small inductances. The method of measurement is that adopted by Max Wien, and is a modification of Maxwell's method of comparing two self-inductances, the source of voltage being alternating, and the indicating instrument a tuned optical telephone or vibration galvanometer.

In the Optical Department two new optical benches constructed for the laboratory by Messrs. R. & T. Beck were shown by Mr. SELBY.

THE OSMIUM INCANDESCENT LAMP.

IN a recent paper read before the Elektrotechnischer Verein, Herr Fitz Blau gives some interesting information in regard to the manufacture and performance of the high efficiency osmium filament lamps of Dr. Auer von Welsbach.

Ever since Edison's experiments on platinum filament lamps, it has been recognised that metallic filaments are in many respects better and more efficient than carbon ones; and yet, owing to the short life of such filaments, they had, until recently, been practically entirely superseded by carbon filaments. In almost every other respect, except the capability of standing a high temperature for long periods, the carbon filament is less suitable for lamp construction than a metal filament. Under the electrical actions which take place in the highly exhausted lamp bulb, the carbon filament gives off a fine dust which has four objectionable results—firstly, the filament becomes thinner, and allows less current to pass, so that less energy is available; secondly, the surface of the filament becomes rougher, and this, as is well known, causes it to approach more nearly to the state of a "black body," and to give out a greater proportion of dark rays; thirdly, the powder collects on the inner surface of the bulb, and so further reduces the available light; and, fourthly, the reduced current lowers the temperature of the filament, and this, in itself, raises the resistance of the filament, and so still further reduces the current.

The ideal requirements for the construction of a long-life lamp over and above the capability of its filament successfully withstanding a high temperature, are:—

1. That the nature of the filament material and of its surface, should be such as to give a maximum proportion of visible radiation.

2. That the material of the filament should be as transparent as possible when in the cold state, so that the powdering over of the inside of the bulb shall have a minimum effect.

3. That the surface of the filament should become smoother rather than rougher during use, as this improves the proportion of visible rays.

4. That the electrical resistance temperature coefficient should be positive rather than negative, so as to counteract the effect of any lowering of the filament temperature.

In all these respects platinum surpasses carbon. It has long been known that other metals, such as chromium, molybdenum, vanadium, wolfram, tantalum, as well as the metals of the platinum group, iridium, ruthenium and osmium, can withstand a far higher temperature than platinum itself, but these metals have hitherto been excluded because of the difficulty of producing them in the form of very fine wires.

After numerous experiments, Auer von Welsbach arrived at the conclusion that the best metal all round for the purpose was osmium, and about six years ago he succeeded in obtaining this in the form of the necessary fine wires. It was found impossible to obtain these wires by direct drawing or rolling, owing to the brittleness of the metal, so the first filaments were made by covering an extremely fine platinum wire with a coating of osmium and then melting out the platinum. The smallest diameter of filaments, however, successfully obtained by this process, was about $\frac{1}{10}$ mm., and this was only suitable for currents above 1 ampere, so that this method was soon abandoned. The next method tried, consisted in mixing finely divided osmium into a paste with various binding materials and drawing fine cotton fibres through it. After drying the fibres are carbonised. This method has now been superseded, and the latest osmium filaments are produced by the following process:—Very finely divided osmium is mixed into a thick paste with organic binding material, and this is pressed (or squirted) through diamond or sapphire dies at high pressure. In this way a thread, consisting chiefly of osmium and carbonisable material, is obtained, and by moving a flat sheet to and fro under the issuing thread the latter is obtained in the form of loops. These loops are dried and rendered incandescent in vacuum, so as to carbonise the binding material, and are then ready for the most important part of the process—known as "formation." This consists in subjecting the porous thread, consisting largely of carbon, to a gradually increasing temperature in an atmosphere saturated with water

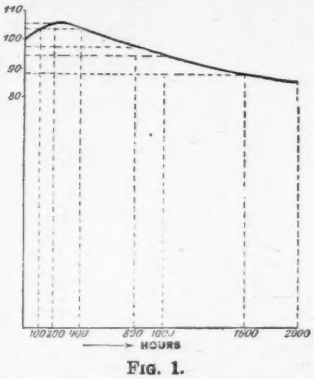


FIG. 1.

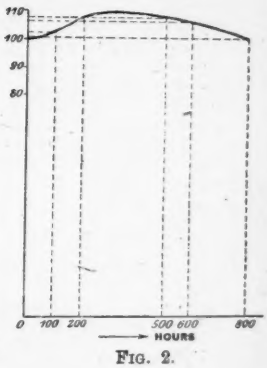


FIG. 2.

vapour, and containing, also, a varying proportion of reducing gases. The heating is effected by a gradually increasing electric current, producing finally a white heat, which is continued for a considerable period. Under these conditions a reaction, similar to that employed in the production of water gas, takes place, and results in the complete dissipation of the carbonaceous material, leaving a filament composed almost entirely of pure osmium. The density of the filament now is much greater than in its original state, but it is still porous, and has by no means a smooth surface. The roughness of the surface, in fact, plays a considerable part in lengthening the life of the osmium filament. Connection between the osmium filament and the platinum leading-in wires is made by melting the platinum around the osmium by means of an electric arc. The fact that osmium is brittle in the cold state but soft at the incandescent temperature gave considerable trouble at first, as it prevented the filament being wound into a spiral, like a wire. On this account the ordinary lamps are made suitable for burning in one position only, although, when required, special lamps, in which the filament is supported at additional points, are made for burning equally well in all positions.

The first lamps put on the market were for only 37 volts, and hundreds of thousands of such lamps are at present installed, either several in series on the ordinary supply voltage, or simply with the voltage reduced by means of auto-transformers. The possible voltage has, however, been rising steadily, and just recently 110-volt lamps, possessing all the good qualities of the lower voltage ones, have been produced by employing filaments wound in the form of a spiral—the diameter of the spiral being only a fraction of a millimetre, so as to prevent the turns of the spiral opening out when hot.

The osmium filament of a 37-volt 25-C.P. lamp, having an energy consumption of 1½ watts per candle-power, has a diameter of about 087 mm., and a length of about 280 mm. The resistance coefficient is ·095 at 20° C., and is 8·4 times as great at the white heat corresponding to the normal rating of an osmium filament, viz., 1½ watts per candle. The radiating surface per candle-power at this rating is 3 to 3·2 sq. mm., whilst if an ordinary carbon filament were pressed up to an efficiency of 1½ watts per candle-power, its radiating surface per candle-power would only equal 1·6 sq. mm. Obviously therefore, the carbon filament must be raised to a higher temperature than the osmium filament, and must more closely approximate to the state of a "black body."

Owing to the increase of the resistance of osmium with the temperature, a rise of 10 per cent. in supply voltage will only produce a 6·5 per cent. increase in current, and about a 40 per cent. increase in light, whilst with the carbon filament, the current would increase 12 per cent. and the light 80 per cent.

The useful life of an incandescent lamp is usually taken as that period within which the original candle-power is lowered by 20 per cent. If this rule is applied to an osmium lamp, the useful life and the actual life would be practically coincident, because these lamps do not fall off by 20 per cent. in candle-power in less than about 2,000 hours. Fig. 1 shows the variation of light (stated as a percentage of the original candle-power) from osmium lamps of 25 to 32 C.P. at 37 to 44 volts. Fig. 2 shows the same curve (only continued for 800 hours) for 110-volt, 32-C.P. lamps. Lamps with such extreme lengths of life as 5,000 and 6,000 hours, have been obtained not only in isolated cases, but quite often in spite of the

fact that the expense of such lengthy tests prohibits their being carried out at all frequently. Out of seven lamps tested at the Reichsanstalt for 2,000 hours, all but one were in a satisfactory working state at the end of the test. In ordinary practical cases, too, the results are very satisfactory. For instance, in a particular installation, working since October, 1902, with an average yearly lighting period of 800 to 1,000 hours, less than 10 per cent. of the lamps have had to be replaced up to the present.

The writer suggests as the probable causes of the long life of these lamps (1) the fact that at the 1½ watts per C.P. rating the filament is only very moderately loaded; (2) the fact that the filament when it leaves the factory (even after having been burnt there for several hours to let it arrive at approximate constancy) is by no means in a finished state, but continues to diminish somewhat in diameter, owing to the gradual disappearance of roughnesses from the surface. This reduces the surface, whilst approximately the same watts have to be dissipated so that the temperature and light increase, and serve to counteract any tendency to reduced candle-power; (3) the fact that the glass bulb does not become blackened. This last result is probably also due to the low rating of the filament, and may be compared to the effect on the life of a carbon filament lamp, if run at, say, 6 or 7 watts per C.P., in place of the usual 3½ watts. Attempts have been made to press up the rating of the osmium lamp, for instance, to 1 watt per candle-power, but experience has shown that structural and molecular changes in the filament supervene, and reduce the life of the lamp unduly.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

11,223. "Improvements in or relating to dynamo-electric machines." F. E. Berry. May 29th.

11,243. "Improvements in electric arc lamps." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) May 30th.

11,260. "Improvements in electric cables." A. Whalley and E. A. Bayles. May 30th.

11,290. "Telephone exchange systems." F. W. Dunbar. May 30th.

11,300. "Improved manufacture of copper sulphide for thermo-electric couples." Compagnie Thermo-Electrique (Systeme Hermite) Soc. Anon. (Date applied for under Patents Act, 1901, April 27th, 1905, being date of application in France.) May 30th. (Complete.)

11,301. "Improvements in sulphide of copper thermo-electric generators." Compagnie Thermo-Electrique (Systeme Hermite) Soc. Anon. (Date applied for under Patents Act, 1901, May 3rd, 1905, being date of application in France.) May 30th. (Complete.)

11,329. "Improvements in trolley wheels for electric traction." J. A. Kidd. May 30th.

11,336. (Same as 11,337.)

11,337. "Improvements in telephones." J. E. Kingsbury. (The Western Electric Co., United States.) May 30th. (Complete.)

11,344. "Improvements in and relating to insulators for electric conductors." R. N. Redmayne. May 30th.

11,353. "A process for regenerating electric accumulators." C. Luckow. May 30th. (Complete.)

11,388. "Improvements in devices for controlling trolley-pole ropes." J. Fielding and J. Schofield. May 31st.

11,407. "Improvements in electric heating apparatus." G. Teuber. May 31st. (Complete.)

11,415. "Improvements in apparatus for measuring electrical resistances." Eversheds & Vignoles, Ltd., and S. Evershed. May 31st.

11,424. "Improvements in apparatus for controlling electric currents." A. N. Frisby.

11,440. "Improvements in connection with single-phase alternate current electrical motors provided with commutators." The Elektrizitats Akt. Ges. Vormals W. Lahmeyer & Co. (Date applied for under Patents Act, 1901, July 11th, 1904, being date of application in Germany.) May 31st. (Complete.)

11,441. "A device for limiting the speed of compensated single-phase alternate-current motors." The Elektrizitats Akt. Ges. Vormals. W. Lahmeyer & Co. (Date applied for under Patents Act, 1901, July 30th, 1904, being date of application in Germany.) May 31st. (Complete.)

11,442. "Improvements in the manufacture and production of coils of wire, more especially intended for use in electrical measuring instruments." Hartmann & Braun Akt.-Ges. (Date applied for under Patents Act, 1901, June 16th, 1904, being date of application in Germany.) May 31st. (Complete.)

11,454. "Improvements in means for automatically regulating the load on engines or motors used for driving electric generators." Helios Electricitats Aktiengesellschaft (in liquidation). (Date applied for under Patents Act, 1901, June 1st, 1904, being date of application in Germany.) May 31st. (Complete.)

11,460. "Improvements in and relating to fusible electric cut-outs." The British Thomson-Houston Co., Ltd., and E. B. Wedmore. May 31st.

11,462. "Improvements in electrical connections." W. E. Burnand. May 31st.

11,470. "Improved electric cables." W. Bacon. June 1st.

11,484. "Improvements in electrical automatic cut-outs." E. W. Cowan. June 1st.

11,491. "A self-contained electric bicycle bell." J. W. Perry and J. W. Perry, Jun. June 1st.

11,494. "Improvements in and relating to sealing devices for electricity meters." W. Hamilton and Ferranti, Ltd. June 1st.

11,502. "Improvements in dynamo-electric machines." G. (known as A.) Berry. June 1st.

11,523. "Improvements in the manufacture of wire and the like by electro-deposition." June 1st.

11,531. "Improvements in radiators." L. F. Pearson. June 1st. (Complete.)

11,534. "Improvements in and relating to electrical conductors adapted to be used for commutators of dynamo-electric machines and other purposes." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) June 2nd.

11,535. "Improvements in regulators for dynamo-electric machines and the like." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) June 2nd. (Complete.)

11,536. "Improvements in and relating to electric motor control systems." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) June 2nd.

11,537. "Improvements in and relating to electric motor control systems." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) June 2nd.

11,538. "Improvements in systems of overhead electric railways." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) June 2nd.

11,600. "Improvements in dynamo-electric machines." G. (known as A.) Berry. June 2nd.

11,605. "Improvements relating to retransmitting and reinforcing telephone currents on lines also used for telegraphic purposes or otherwise liable to have currents of relatively low frequency passing over them." J. E. Kingsbury. (The Western Electric Co., United States.) June 2nd. (Complete.)

11,606. "Improvements in telephone current retransmitting and reinforcing apparatus." J. E. Kingsbury. (The Western Electric Co., United States.) June 2nd. (Complete.)

11,614. "Improvements in electric traction." J. S. Raworth. June 2nd.

11,626. "Improvements in protective devices for alternating current systems." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) June 2nd.

11,627. "Improvements in systems of electric distribution by means of rectified alternating electric current and in apparatus therefor." The British Thomson-Houston Co., Ltd. (The General Electric Co, United States.) June 2nd.

11,635. "Improvements in the trembler blades of contact-makers for electrically-fired internal combustion engines." A. A. Donald. June 3rd.

11,673. "Portable electrical measuring instrument." H. Bourgeois. June 3rd. (Complete.)

11,685. "Improvements in multiplex telegraph systems." T. Giara. June 3rd. (Complete.)

11,702. "Improvements in dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) June 3rd. (Complete.)

11,703. "Improvements in and relating to dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) June 3rd.

11,705. "Improvements in and relating to electric arc lamps." The British Thomson-Houston Co., Ltd (The General Electric Co., United States.) June 3rd.

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Lightning Arresters. E. A. Carolan. (General Electric Co., U.S.A.) 11,649. May 21st.

Switches. J. Jones. 11,706. May 22nd.

Dynamo-Electric Machines. E. A. Carolan. (General Electric Co., U.S.A.) 11,729. May 22nd.

Controlling Motors. E. A. Carolan. (General Electric Co., U.S.A.) 11,730. May 22nd.

Telephone Switchboards. H. H. Lake. (Elektrisk Bureau.) 11,738. May 22nd.

Coin-Freed Apparatus. H. H. Lake. (G. Sem, Norway.) 11,739. May 22nd.

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Induction Coils. J. Splitdorf. 13,983. June 23rd. (Date applied for under Patents Act, 1901, April 8th.)

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Mercury Vapour Lamps. F. W. Le Tall. (Cooper-Hewitt Electric Co., U.S.A.) 14,170. June 25th.

Mercury Vapour Lamps and Electric Converters. F. W. Le Tall. (Cooper-Hewitt Electric Co., U.S.A.) 14,171 and 14,175. June 25th.

Electric Distribution. F. W. Le Tall. (Cooper-Hewitt Electric Co., U.S.A.) 14,172 and 14,174. June 25th.

Cut-outs and Switches. F. W. Le Tall. (Cooper-Hewitt Electric Co., U.S.A.) 14,173. June 25th.

Cut-outs. R. W. Bill. 11,765. May 23rd.

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Couplings. S. A. Hunter. 12,189. May 28th.

Railway Signals. H. F. Parshall and E. Parry. 12,218. May 28th.

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Dynamo-Electric Machines. W. E. Burnand. 14,770. July 2nd.

Electric Arc Lamps. E. R. Viale. 15,481. July 13th.

Boots. F. B. Lee. 15,504. July 13th.

Dynamo-Electric Machine. E. A. Carolan. (General Electric Co., U.S.A.) 15,591 and 15,592. July 14th.

Arc Lamp Hanger and Switch. E. A. Carolan. (General Electric Co., U.S.A.) 15,595. July 14th.

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Secondary Batteries. H. Ramsbottom and J. M. Richardson. 16,808. August 1st.

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Electric Arc Lamps. C. E. Foster, E. R. Grote and M. V. Ely. 19,491. September 10th.

Dynamo. W. E. Evans. (Gesellschaft zur Einfuhrrung von Erfindungen, Germany.) 19,896. September 15th.